Metallurgical and Chemical Engineering

Contents for November 15, 1916

Where Will These Profits Go?

There is a great deal of jubilation these days over the profits we are making. It is said that we are growing rich; the wealth of the United States is increasing rapidly. The common concept appears to be that of taking the United States as a business enterprise; its raw materials are costing it so much and its sales of finished product are vastly larger, hence great profits, paid us in gold, in Anglo-French bonds, French rentes, etc., and in American securities formerly held by our customers.

Now, we want to know. What is there in this? Some who have studied the matter, with statistics a-plenty, find that our favorable trade balance since the war started has enriched us, to Oct. 1, by more than four billion dollars. That is a huge sum, so large that it may silence argument, and yet we may venture to study it a little. Suppose it reaches five billions in the near future, as probably it will. What is the United States going to do with it? Suppose "we" invest it at 6 per cent. Then we should have $300,000,000 a year income, or $3 a year for each man, woman, and child of us. We are pensioned off, and don't need to work any more. Every three months we deposit our coupon in the bank and draw seventy-five cents, less three-quarters of a cent income tax unless we can claim exemption.

Now, the seventy-five cents every three months may do us good, but the idea that we don't need to work any more won't do us any good. We have known such an idea to do people harm, even when it was true, and in this case it isn't. There are a great many cases of a young man being trained up to work like his father and suddenly pater dies without having tied up his estate, and the young man goes the pace.

Of course, our relations with the world are changed. We shall not need to export much more merchandise than we import, insofar as we have hitherto had to do so for the purpose of paying interest and dividends on such of our securities as were held abroad. The securities have been largely returned to us, and we have purchased foreign securities, so that in future we can, so far as this goes, import more merchandise than we export. But there is an item we have noticed that is often lost sight of. Something occurred whereby the securities mentioned originally came to be held abroad, and it appears that the occasion was that we did not export a sufficient surplus of merchandise, over what we imported, to break even. That was a bad habit to get into and with this new idea of ours, how rich we are, we may become still more confirmed in that habit, and that is certainly not a good thing either.

As a matter of fact, this business of the United

States is not that of a corporation. It is merely the aggregate of what individuals, firms and corporations are doing. It is a question of what the individuals will do. The profits are not distributed per capita, but are somewhat tightly held. The prosperity of the country is simply the prosperity of the individual. If the individual's ordinary living expenses are increased, by these times, more than his income, he is worse off. He spends as much but he receives less in return, in quantity. Those who are amassing large profits will in time spend them or invest them. That sounds good, but a rather clear argument can be built up that periods of industrial depressions in the United States have always followed periods in which there was too rapid conversion of liquid into fixed capital, too much new construction. *Post hoc, ergo propter hoc.* If the people had been able to patronize the works built they would have earned money year by year, but they could not do so. Which suggests that if the war is to be followed, as is generally being predicted, by a great rush of capital into investment in the United States, the success of the ventures is going to depend largely upon whether the rank and file will find themselves in position to patronize the new factories, or mines, or stores, or whatever it may be that are going to be established.

Guayule Rubber

We print in another column a contribution on Guayule rubber, which we commend to the thoughtful consideration of our readers. It made us thoughtful in another way at the very first glance; thoughtful of Intercontinental Rubber with dividends of 4 per cent on common stock and prospective earnings way up—say 50 per cent.

It was a romantic story. There was any amount of Guayule shrub in Mexico which was brought in by peons, as our correspondent says. The trouble at this point, as he also intimates, was that the peons, in true Mexico-Berserker fashion, ripped and tore up by the roots everything that grew in the desert except cactus. The cacti were spared by their spines. So the doomsday of desert rubber hove in sight. But in the bright lexicon of a rising stock market there's no such word as fail. Land was secured and water brought down from the mountains for the culture of the plant of dolor, under enlightened conditions. The shrub was accustomed to a hard life with little water; so it took about thirteen years to mature on its native wastes. Our correspondent refers to five years as the time for maturity, which may be the period under modern culture. We do not know, except that "they said" in the grand old days of dividends and desires in sight, that it took about thirteen years out in the desert. In the meantime it had been discovered that with the help of irrigation the plant matured in two years, and the stock of the Intercontinental Rubber bounded skyward. The tip was passed around that they had the whole rubber situation "cinched"—which was a good, if not a final argument.

Following this came another discovery that the shrub, transplanted to more favorable surroundings with the precious water, theretofore so scarce, brought to it in such abundant measure, had no more need to secrete a heavy sap—and so it didn't. It grew like a green bay tree, but it did not grow rubber.

Now followed the beginning of the present series of Mexican revolutions, and Intercontinental stock tumbled. It ceased to be banking collateral, and it was, in the language of the street, "closed out" in many instances. There are, however, always insiders and outsiders, and, as is usually the case, the outsiders ceased to believe in guayule rubber. It was inferior at best. Crude guayule, as it was called, brought about 60 per cent of the price obtained for up-river fine Para and Ceylon plantation. It was sticky and messy. But it was rubber, and rubber chemists knew how to deal with it. They also knew how to mix it. So those who believed in guayule did the unusual thing and took professional advice—botanical advice, in fact. Lately a rumor has grown current that this has met with marked success after patient research. Information as to details is not available, but the rumor persists that the shrub may be and is grown under irrigation in Arizona, and by that learned and judicious strategy which is the substance of research, the irrigated plants do secrete the gum in abundant measure.

That we should have a source of rubber supply within our shores is very desirable. We hope, with an enthusiasm so intense that we should only appear ridiculous if we were to try to express it, that war may go out of fashion, but the wish does not remove the need of self-containment by nations.

Here, then, is a rubber-producing shrub that may be grown in the United States. The extraction of the gum and its chemical treatment is reasonably provided for. The problem whether it may be grown economically or not is a question within the great realm of botany. It is exceedingly interesting, and proves again the need of the correlation of all the sciences in industry.

Railroads and Iron Production

Car shortages throughout the country direct attention to the dependence of the iron and steel industry upon the railroads. It is feared that a railroad blockade, comparing in seriousness with the memorable one of 1902-3, will be upon the country within a few weeks, for railroad facilities are already strained to their utmost and the change that may occur overnight from very favorable to distinctly unfavorable weather conditions will instantly reduce the train movement. When the railroads are working at their best the first cold snap of early winter always slows down the movement, whereas of late they have been working with difficulty and with no reserves of motive power or men.

Pig iron is being made at the rate of about 114,000 gross tons a day. The major portion of the ore consumed, probably about 90 per cent, must be moved by railroad for longer or shorter distances, involving about 195,000 tons of ore a day. About 75,000 gross tons of the coke consumed moves by rail, and substantially all the limestone, about 55,000 gross tons. The amount of slag that must be removed by rail may be roughly

estimated at 25,000 tons. About 40,000 tons of the pig iron produced is carried away by rail, the balance being consumed at the point of production. Here is a total of 400,000 gross tons daily of freight movement over railroads involved in blast furnace operations alone. For each ton of steel ingots produced there is required about one net ton of coal, for steam and gas at the steel works, while some finishing operations require large quantities of coal. In the making of tin plate the steel is heated six times, four times in the rolling process and twice for annealing. Allowing that only two-thirds of the steel industry's coal consumption is moved by public railroads the daily coal movement is probably about 50,000 gross tons. The movement of semi-finished steel from steel mill to finishing mill, as in some cases the operations are detached, and the movement of finished steel products from mill, involve more than 100,000 tons a day in addition. Making allowance for incidentals, there is a total railroad movement of about 600,000 gross tons per day to take care of the blast furnaces and steel works, disregarding entirely the foundries. The computation is on the basis of movement each of the seven days in the week, although loading and unloading is usually confined to six days. This represents about 250,000,000 net tons a year, or about one-eighth the total freight movement of the railroads, disregarding mileage. Inasmuch as the iron and steel industry is confined largely to certain districts the proportion is very high in the iron and steel sections.

For the iron and steel industry to operate at its best, for it to produce the tonnage to which its units are in themselves physically adequate, it is necessary that nearly all of this freight movement be continuous from day to day. The flow must be steady. The modern bee-hive coke oven is equipped with automatic drawing and loading machinery, and cannot stock coke. It is inconvenient for the blast furnace to stock coke. Coal storage facilities are usually limited, while at the present time there are no stocks, irrespective of the storage facilities. The blast furnaces equipped with casting machines usually load directly to the railroad car. The stocks of pig iron are almost *nil;* if pig iron production decreases the steel making units must slow down, and there are practically no stocks of cold ingots, or of billets, slabs, sheet bars, etc. If the steel mill slows down, so must the finishing mills. If the finished steel products cannot be shipped the production must in many cases be curtailed.

Thus any curtailment in shipping facilities is certain to decrease the production of iron and steel, at a time when the industry is straining every nerve to produce the maximum. A decrease in steel production will not operate to prolong the period of heavy demand, for the limit is not one of tonnage, but of time, meaning the end of the war. After that there will be new conditions, and of course new demand, but that will be an entirely separate period with its own times of delivery and its own prices. The present task is to produce the maximum number of tons before the time limit is reached.

Electric Properties and Microstructure

The mechanism of electrical conduction through solids has been the subject of much mathematical speculation on the basis of the electron theory. Recently, however, the subject has been attacked experimentally from a new viewpoint with considerable success. The new viewpoint is the connection between electric conduction and microstructure. It is an exceedingly profitable and promising viewpoint.

In our issue of Oct. 15 (page 464) we published a full abstract of a very interesting paper of fundamental importance by Dr. Colin G. Fink read at the last New York convention of the American Chemical Society in which the conclusion is reached that the electrical conductivity of a substance is primarily dependent upon the shape and the distribution of the fundamental grains or particles comprising the substance, and secondly, upon the presence or absence of thin films of secondary material enveloping these ultimate grains. On the basis of this theory it is possible, as Dr. Fink points out, to account for the comparatively high conductivity of gels that contain but a trace of conducting material. It is also possible to account for the marked difference in resistance, for example, of two samples of commercial copper, whose chemical composition is identical, depending upon whether the impurity, such as sulphur, is uniformly dissolved in the metal or whether it forms a film ("cement") of copper sulphide around pure granules of copper. The latter case is to be regarded, as Dr. Bancroft suggests, as an emulsification of copper in copper sulphide. The high resistance of these surface films composed of, say, sulphide or oxide or arsenide accounts for the high resistivity values of copper where but a trace of the impurity is present.

A paper by Prof. Edward D. Campbell of the University of Michigan, presented at the recent London meeting of the (British) Iron and Steel Institute, deals in a suggestive way with a closely related subject. The paper discusses the influence of heat treatment on the thermo-electric properties and specific resistance of carbon steels. The paper gives the results of a large number of tests of carbon steels ranging from 0.018 to 1.05 per cent in carbon and differing little otherwise so that the results are comparable. For each sample the electric properties depend very largely on the heat treatment because the heat treatment determines the microstructure, and, in fact, from the table of the specific resistance the progress of the precipitation of the carbides, due to heat treatment, can be easily followed. Further, there is a distinct parallelism between the thermo-electromotive force and the specific resistance of the different steels, as influenced by chemical composition and heat treatment, and Professor Campbell concludes that both the total specific resistance and the total thermo-electromotive potential of steel are made up of two components: that due to the solvent iron and that due to the carbide solutes. Professor Campbell concludes that this parallelism is strong confirmatory evidence of the essential unity of mechanism of the nature of solid solutions and of aqueous salt solutions.

Readers' Views and Comments

Research Needed in Automobile Factories

To the Editor of Metallurgical & Chemical Engineering

SIR:—Despite all that's said about the incorruptibility of the press, and granting every word of it, the fact remains that the advertiser, the large, full-page, affluent advertiser, is less likely to have his faults made clear than the wayward brother who has been caught with the goods. So the advertiser sometimes suffers from lack of sound advice while the wayward one may get even more than is good for him. This is not intentional; it just happens so.

For instance, there are the automobile manufacturers. They have been signally successful and they are grand advertisers! They take space in a way to fill a newspaper office with joy. While the business management wears out sole leather picking up little driblets here and there and feels triumphant over the disposal of a quarter-column, the automobile man calls for two full pages, regularly, for several months. Then he discounts his bill—which sometimes seems like a great kindness. It is hard to speak save in favor of a man like that!

On all sides, too, editors hear of the marvelous mechanical efficiency of their works; how they seem to have matters down to such a system that trainloads of iron, steel, upholstering materials, rubber for tires and noise for horns to go in, each at its separate entrance, and down the grand slide come great processions of finished cars, perfect in every detail, propelled by their own power. It is glorious!

But suppose this little unconscious advantage did not exist in favor of the advertiser and the automobile man had not enjoyed that freedom from criticism which experience may be teaching him to regard as his vested right. Suppose he had been looked upon as common clay—as an oil refiner, let us say. Things might have been different.

Here is a great industry engaged in the manufacture of machines and their accessories. The machines are explosion engines and the accessories are, in fact, wagons. It is not, when we come to think of it, such an overwhelming problem. It is like opening up a rich mine: it takes engineering skill and good management. When you come down to it, it hardly calls for supreme genius; especially when we consider the number of men engaged in it, the whip of competition and war-time profits. Let us, however, grant all the praise that is demanded; admit everything that is wished for; compare the automobile engineers and manufacturers with George Washington, Abraham Lincoln, Charlemagne, Cyrus of Persia, Alexander the Great—do everything possible to make things satisfactory and then take a little inventory of conditions.

Here is a great industry making automobiles. They are driven by gasoline. There is not enough gasoline to go round; automobile production is increasing faster than gasoline production. So the price of gasoline goes up. The increase of fuel costs affects the sale of motor cars and thus we meet the familiar situation in which "something must be done."

The manufacturers have responded by the time-honored process of cussin' out the Standard Oil Co. It has the merit of ease, tradition, and the Standard people are used to it. Whether it is good for them or not we shall not undertake to say; we only know that to blame the old Standard company or its amazing progeny for any ill that may occur seems traditionally correct; and nobody complains. If the price of gasoline goes up, of course the Standard Oil Company is to blame and as for the other refiners, they are easily dispensed with with the remark that they are "in the ring." Then the time is ripe to whack the refineries again. "And gasoline ain't as good as it used to be," say the ultramillionaires of the automobile. We have even heard threats that the automobile makers will refine oil themselves, and then, by gosh, by golly, by Judas, by guy, by ginger, by crackey, by gum—they'll just take and go to work and *make* gasoline!

When people grow as rich as the automobile men it is hard to think that others are doing their best. And yet the oil refiners have been at work. The task of furnishing enough gasoline has been even more difficult than profitable—and that is saying a great deal.

Now the design of an engine to be propelled by gasoline is legitimately the problem of the automobile engineers, but the restriction of these engines to the use of gasoline has also been a self-imposed limitation by the same group of savants. There is kerosene and export oil, both hydrocarbons that explode with air and are available for explosion engines. The oil refiners may be induced to sell these fuels at really low prices without either moral suasion or threat. True, they are a little difficult to start when used in the place of gasoline and they do coke up the cylinders, which are faults that may only be remedied by research. It is a problem in chemistry and mechanics. Whether it may be accomplished by an oxidizing agent or a new carbureter or some little twist o' the wrist is a question to be answered by research. Some trucks are beginning to operate with part kerosene or nearly all kerosene, but the art is not yet developed. The automobile people have the testing facilities, the wealth and the opportunity far better than the refiners, because they use the fuel whereas the refiner can only sell it. But the automobile people appear to have been lazy and inert in this matter. They have not contributed their share of research. They have recognized the shortage of motor fuel and their chief contribution to the general welfare in the dilemma has been to decry the oil refiners. That is not illuminating nor is it helpful, except as it may satisfy the conscience of the automobile men; neither is the argument scientific.

We Americans have long suffered from chemical blind spots and the way to overcome them is to recognize them first. Now the automobile men have enjoyed so much praise and so little criticism that they have not become adequately alive to the fact that explosion engines may be driven by other hydrocarbons than gasoline. Instead of meeting the difficulty they have hollered at it. And we learn, usually, rather early in life, that this method looses effectiveness in the solution of problems that call for research. It seems as though the time were at hand for automobile makers to dry their eyes and spend some money on well directed investigation. It may surprise them to learn that the refiners will be glad to help them.

There has been plenty of research in the art of making gasoline, but in the art of adjusting engines to fuel and fuel to engines, those who need it most have been talking in their sleep. PETER TEN BROECK.

New York City.

Interesting Points in the U. S. District Court Flotation Decision

To the Editor of Metallurgical & Chemical Engineering

SIR:—The U. S. District Judge Bradford in handing down his decision makes a statement which should interest the mining industry very much. In the following I will quote a paragraph of the decision as printed in your issue of Oct. 15:

"In what was known as water or gravity concentration the ore was mixed with water forming the ore pulp, and through shaking or agitation of the pulp by well-known devices the metallic particles, becoming separated from the particles of gangue, and having greater specific gravity than the water, sank to the bottom, while the particles of gangue, having less specific gravity than the mineral particles, although greater than that of the water, were subjected to an up-current, not strong enough to prevent the metallic particles from sinking, but strong enough to carry the particles of gangue to the surface, where they would escape over the edge of the containing vessel or be otherwise disposed of. *Such processes, however, were far from commercially successful*, being wasteful of water, of power and of a considerable proportion of the metallic particles in the slimes which were carried by the up-current to the surface and were lost with the gangue."

In many years of experience in the concentration of ores the writer has failed to run across a concentrating method using an up-current of water for means of water concentration. Evidently the court refers to jig practice or table concentration. In neither case, of course, an up-current is used. In a jig, as is well known, a pulsating current is used and on a concentrating table a transverse current is used. When the court described the method as "what is known as water or gravity concentration," and refers to "shaking and agitating the pulp," there can be no room left for the reader to understand that the court refers pure and simple to gravity concentrating methods. The statement made by the court that such processes, however, "are far from commercially successful" is quite radical, and can hardly be taken otherwise than that the court was unfamiliar with these methods. Millions upon millions of dollars' worth of minerals have been and still are being concentrated by the good old gravity-concentration methods, and to dispute their commercial success is doubtless a strong undertaking. It might interest Judge Bradford to know that the gravity-concentration process is still used for the concentration of by far the greater portion of the world's mineral production, and if flotation would be adapted by a great many producers who now use water concentrating methods in place of the same, they would undoubtedly suffer considerable losses. Flotation concentrates of zinc ores, for instance, is very much penalized by smelters on account of its fineness. It can also be stated that the flotation process is up-to-date unsuccessful for the commercial separation of one mineral from the other, and some flotation concentrates have to be retreated by the gravity method.

It may be true that the quotation of water concentration in the decision has no bearing upon the subject, but then why is this reference made? If, on the other hand, there is a legal value in making the comparison, then surely the decision embodies the description of a standard well-known method, which is incorrect in every detail. Some doubt must naturally arise whether or not the subject has been properly presented to the court, when right in the outset of the opinion the court refers to and compares the patent in question with an old and highly successful method of concentration, and calls same "far from commercially successful." If the patentability of the process of the plaintiff rests partially upon the greater success attained by this process over the older methods, then surely the older methods should be well known to the court and the old water-concentration method surely deserves a little more credit than given to it by Judge Bradford.

Going on with his opinion the court states that "no one to-day understands how the use of only 0.1 per cent of oil operates to secure the mineral froth." This surely is an interesting and vital admission, aside from the legal aspect, whether or not an inventor ought to understand the workings of his own conception and whether he can be credited with and given a monopoly upon a process based upon something that he does not understand himself. This will undoubtedly be decided in due time by the higher courts. In this case, however, it is admitted that many other patents have been granted prior to the patents of the plaintiff, and practically the only difference is the very point that no one understands. Does not this at least leave the matter in very doubtful condition?

In an editorial of the same issue of the METALLURGICAL AND CHEMICAL ENGINEERING the court is credited with making the statement that the "presumption of validity arises from the grant of letters." If this holds good in one case it surely holds good in all, and why should not the inventors of the other patents cited get the benefit of that same argument when they applied for and received letters of patents upon something that they have clearly described and understood, and particularly when there are great numbers of such patents issued upon substantially the same subject as against the small minority of patents set forth by the plaintiff, which are all based upon something which neither the court, nor the experts in court, nor the plaintiff, nor the inventor understand. If a thing is not understood then this thing cannot be considered a fact. If a thing is not a fact it cannot have any standing before the law.

The court also quotes that "when the old mode of operation and its result, through a decrease in the amount of oil, disappear and a new and different result is disclosed, the change ceases to be one of mere degree and may support a patent monopoly." This is undoubtedly true, but where does the old mode of operation and the result disappear? The old mode of operation has been, and the new one is, the agitation of ores with water and oil, and the result is and has been a more or less complete separation of the mineral and gangue constituents. The quantities of oil used is, in practice if not in law, a matter of degree or rather quantity. The technical effect which is primarily a thing upon which a patent stands is the same.

I am in a position to make a demonstration of my old patented process, which has been cited in court, and in such a demonstration I am satisfied I can make a better separation than is possible with the process in question. It may be possible, although I do not feel sure about it, that the other process may make a better separation in some cases, but we all know that no concentrating process is a sure cure for every ore, and that one ore is more amenable to one than it is to the other. The great and important item, of course, in every commercial operation is economy. When an inventor is granted a monopoly over others that have worked on the same principle and produced certain results, the whole history of this process should be taken in consideration. The history shows it has been known prior to the date of the U. S. patents of the plaintiffs that sulphide mineral has a certain affinity for oil. Upon this the early start of the art was based. Agitation, of course, was necessary to bring the oil in contact with the ore. With a lesser degree of agitation more oil had to be used, and with a greater degree of agitation

the oil could be diminished. In the early beginning both Mr. Elmore and myself were working on the same principle, not knowing of each other, as well, perhaps, many others, and we all devoted our attention to the recovery of the oil after it had once been used.

In 1906 I visited the Elmore Laboratory in London. That was after I had my own process developed and patented, and both he and myself used, in those days, centrifugal driers to recover the hydro-carbons from the concentrates. I also built hydraulic presses, pressing the concentrate into briquette form, thereby extracting the hydro-carbon, but it soon became apparent that an insufficient extraction of the oil was only possible. I then devoted my attention to the reduction of the original quantity of hydro-carbon used, and I assume that everybody else active in this field did the same thing. It became largely a question to distribute the small quantities of the hydro-carbon used over the large bulk of water and ore and still bring the hydro-carbons in contact with the mineral.

Rapid agitation developed to be one means. There were other methods which I used, and patent applications were filed as early as 1906, and I am in a position to produce evidence to that fact through the U. S. Government's records. I do not feel that I should disclose at present what these means were, since to my knowledge no one else has ever attempted to use the same. This much, however, is certain, that everyone working on this principle tried to reduce the amount of hydro-carbons used to a minimum. In doing this I, for one, found that aeration was helpful, and employed same. The aeration was shown in one of my patents, and I understand that the machine used for that purpose was demonstrated in court by the plaintiff, naturally, in such a manner as to bring out his own contention. It must be admitted that no one was so familiar with the operation of this machine as I myself. Had I been consulted or asked to make a demonstration it is quite likely that the court would have put a different construction on my patents.

Issued patents are of course, available to everyone and it is only natural that one inventor will study the other man's patent and benefit by whatever is disclosed, whether it may be helpful of producing results or will show the negative side of a process. I myself have studied other patents and have found many things in them disclosing to me reasons why certain things are detrimental in the process of flotation and in order to understand thoroughly any method of doing a thing one should know the defects and the causes for such defects just as well as the merits. It was by this process of evolution that the flotation process was developed, by no one man, but by quite a number of them, and it is in my opinion unjust that a concern which has purchased a few of the patents issued on such developments should be given a monopoly on a process partially based upon the work of a great many other patentees.

The chemistry of hydro-carbons whether organic or inorganic is very complex and it will take many years before there is a true science of flotation developed, and no one to-day should be permitted to hamper the development of the flotation process by the grant of a monopoly. The flotation process requires improvements and developments, and its progress will be badly retarded by placing it in the hands of a single concern. It has been clearly shown that a great many men have produced decided improvements over the process such as used by the Mineral Separation Company, particularly in later years, and all those contributing to the development of that process should have their fair share in the patent rights, as well as in the financial compensation, and it must be strongly considered that the public is, after all, the greatest benefactor of any development which turns present-day waste into money.

Fortunately, the term oil as used in the plaintiff's patents constitutes a limitation, and even if the Separation Company will win finally, this can and will not exclude others from using hydro-carbons that are not oils. I have used chiefly rosin, paraffin and beef-tallow in my early work, and obtained results far superior to results obtained by oils, and I hereby contend that an oil is not at all essential for flotation, but that certain resinates and stearates are the essential factors in flotation, and that an oil is merely a liquid containing such resinates and stearates and is acting as a carrier for the same. I have been and am concentrating ores without oil, agitation or air, and can demonstrate conclusively that all the essentials claimed in the patents of the plaintiff are absolutely unnecessary for the process of flotation, and if that process can be carried on without any of the features as described by these patents then it is shown conclusively that these patents have not disclosed the basis of flotation. Therefore a basic patent cannot be sustained. A. SCHWARZ.
Webb City, Mo.

Revision of Our Chemical Statistics

To the Editor of Metallurgical & Chemical Engineering

SIR:—The paper by Bernhard C. Hesse, "Revision of Our Chemical Statistics," which appeared in the Aug. 1 issue of your journal (page 143), has been under discussion by various members of the Division of Mineral Resources. Since it appears from this paper that a concerted movement is on foot to obtain better statistics, it may not be amiss to bring to your attention a few of the problems which must be faced by those who are to be asked to undertake this work, as well as point out a few instances of efforts on the part of the Survey along these lines.

The Survey has long been of the opinion that the Government should give the people of the United States more detailed statistical information concerning the various products made from domestic mineral raw materials as well as information concerning imported products. The Survey has attempted in its annual reports on several metals and non-metals to give this kind of information, as you will perceive by studying the marked copies of several reports inclosed.

The statistics of imports published by the Survey are obtained from the Department of Commerce and are not so complete or diversified as could be wished. It is possible that, if a tariff commission is to work on this problem, it may make the schedules more diversified, depending, of course, on the desires of the country as expressed by that commission.

Concerning the statistics of domestic production, the problem appears more simple in some respects. The Survey has in its mineral resources division a trained force which can collect, and has for some reports collected and published, statistics of the finished products in which these domestic materials reach the market. It is entirely possible, with addition to this force, to publish detailed statistics of all products which are made from the materials upon which the Survey now reports, provided the industries are at that point in their development where they are willing to give the detailed information necessary to compile the statistics. That all industries have not reached that stage in their development is evident to the Survey. To cite a specific instance, the natural mineral pigment producers are not all willing to furnish detailed information from which accurate statistics can be prepared. The same is true of some branches of the chemical industry. On the contrary, many industries have shown

their hearty cooperation in the work along these lines that the Survey has attempted in the past.

Another point which must be borne in mind it this: When materials are made by less than three concerns it is not possible without the consent of all the producers to publish the total production because doing so would disclose the operation of individual firms. This is a difficulty which the Survey has had to face in practically all of its work, for its rule is "never disclose individual production without specific written authorization from the producer."

The mineral resources division of the Survey has always been handicapped by insufficient funds. Its appropriations have been the same for many years, but its work has been greatly increased, particularly in the last two years. Many of the things which it would like to have done have not been possible, because of their cost. The Survey has not been asleep to the possibilities of improvement in its work, but rather it has been unable to do everything that seemed desirable.

I have been frank, as it appears to me that those who advocate better and more diversified statistics should know some of the problems connected with the work of compilation. While the Survey is willing to undertake the added burden of preparing statistics of every product which may be naturally considered as falling within its scope, it would not be possible to do this work successfully until all the industries represented are willing to undertake promptly to supply the confidential detailed information which is necessary for the compilation of accurate statistics.

GEORGE OTIS SMITH.
Director, U. S. Geological Survey.
Washington, D. C.

Chemical Import Statistics

To the Editor of Metallurgical & Chemical Engineering

SIR:—I listened with much interest to the very practical suggestions* made by Dr. Hesse at the meeting in Rumford Hall on Oct. 13, relative to obtaining, through the co-operation of associations of chemists, an extension of the classifications of imports of articles concerning which the chemical industries desire more detailed information than is supplied in the tables now issued by the Department of Commerce. Admirable as Dr. Hesse's plan appears, it seemed to me that it might be worth while to point out that the preparation of a list of statistical designations satisfactory to the practical chemists, while an extremely useful contribution, would be only the first step towards any material increase in the number of titles in the official statistics of chemical imports.

Bureau chiefs in Washington will almost always welcome with enthusiasm the co-operation of technical and commercial organizations when this co-operation is intended to improve the practical value of the reports issued by their respective offices, and will carry into effect any suggestions as far as may be practicable. Usually, however, these suggestions imply a material increase of service, and this means more clerks—and more appropriations.

Appropriation committees of Congress are accustomed to the ardor shown by each bureau or division chief for the development of his particular branch of the government service, and they pare his estimates ruthlessly unless these estimates are supported by something more than his own arguments for the usefulness of his work. Some stronger influence from outside the department must be felt, especially when it is a question of spending money for such apparently academic

*See this Journal, Nov. 1, 1916, Vol. XV, Page 515.

work as statistics, the practical value of which is so often doubted by the public.

There must be strong assurances from some influential section that these statistics are worth while and will have a value that justifies Congress in appropriating for whatever additional clerks may be needed in the Bureau of Foreign and Domestic Commerce and the statistical divisions of the customs branches of the Treasury Department. The statement recently printed in the trade journals that a glance at Dr. Norton's census (in proof) of dye imports was worth a million dollars to an American manufacturer of colors, would impress a committee of Congress much more than pages of recommendation from those in charge of such work in Washington. If it can be shown that new industries, or increased profits to our commerce, will result from spending more money on statistics, there will be a likelihood that the appropriations will in time be forthcoming. And the place to present these arguments is before the committees of Congress rather than the executive departments. The latter will usually do all that is possible when the necessary resources are at hand. The time to present such arguments is also important. This is when these matters are actually under consideration, as much of the effect is lost if weeks or months intervene between the filing of recommendations and the meetings of committees. It must be the duty of some one to watch for the right opportunity, with his material prepared in such form that it will carry conviction, not only from the force of the arguments presented, but also from the number and character of the individuals, firms, and associations, or societies represented.

So, too, in the event of a revision of the tariff, much can be accomplished by proper argument before the Ways and Means Committee as to suitable and practical designations. Once a title is imbedded in a tariff law it will appear automatically in the official statistics, and this quite apart from the question of the import duty that may be fixed, or omitted, with respect to the article in question.   A. H. BALDWIN,

Former Chief, Bureau of Foreign and Domestic Commerce,
New York City.

Hyde Flotation Suit

Hearing Before Supreme Court

On Oct. 27 the hearing in the Hyde case (Minerals Separation vs. James M. Hyde) came up in the United States Supreme Court in Washington.

The full Supreme Court was sitting, Chief Justice White with the eight associate justices: Justice McKenna, Justice Holmes, Justice Day, Justice Van Deventer, Justice Pitney, Justice McReynolds, Justice Brandeis, and Justice Clarke.

Counsel representing the plaintiff, Minerals Separation, were Henry D. Williams, Wm. Houston Kenyon, Lindley M. Garrison (the ex-Secretary of War), Frederick D. McKinney, John H. Miller and Odell W. McConnell, while those representing the defendant, James M. Hyde, were Walter A. Scott, Thomas F. Sheridan, George L. Wilkinson, K. A. Babbitt, and J. Bruce Kremer.

Mr. John Ballot and Dr. S. Gregory were present of those of Minerals Separation, but Mr. James M. Hyde, the defendant, was not in Washington.

The case did not reach its hearing until 3.30 p. m. on Friday, the 27th, accordingly there was only one hour spent of the plaintiff's argument when a recess until Monday noon was taken.

At the opening a request was made upon behalf of the counsel for both sides that an additional hour be granted each side; that is, to allow each two and a half

hours instead of the usual hour and a half. The Chief Justice granted this.

It was then stated that it was desirable, in illustration of the argument, that certain metallurgical demonstrations be made in the presence of the court, and that for this purpose a number of metallurgists and experts not members of the bar would have to be present, and permission was asked that they be permitted within the bar. Allowing these demonstrations the Chief Justice demurred, saying that he himself could not see the experiments from the bench, and asked whether it was necessary that these proposed experiments be performed in the court. Counsel for the plaintiff said that it was not necessary, while counsel for the defendant said that it would be satisfactory to have the experiments performed out of court, if the products of the experiments could be brought into court, to which the Chief Justice apparently assented.

Mr. Henry D. Williams then took up the opening of the case for the complainant, going briefly into the history of the case, and in response to inquiry from the Chief Justice explained that there was conflict between the decision[1] of the Appellate Court of the Ninth Judicial District in San Francisco and the decision of certain British courts and the Privy Council of the House of Lords of the British Empire, also with the decision[2] of Judge Bradford in the Miami case; he explained more or less fully the various points involved in these conflicting opinions.

The Hyde case, as brought to the bar of the Supreme Court, is exceedingly simple as to points involved, since it involves simply the question as to the patentability of the claims of patent 835,120 for less than 1 per cent of oil. In this case before the Supreme Court there is no question of infringement, since the Appellate Court in the decision decreed the patent invalid, maintaining that there was a difference of degree only, and not of effect, in the reduction of the oil from the Cattermole proportions to those of the patent in suit. Mr. Williams devoted the hour to a review of the prior art patents, principally Cattermole, Everson, Kirby, and Froment; with the discussion of the latter he ended the hour. He explained that in Mrs. Everson's descriptive matter of the Everson process, for example, in describing how the materials, these "gobs" of oil and sulphide, were carried over in the upcast with the water, she had used the word "floated" instead of saying carried or washed over, and that the defense had unwarrantedly seized upon this word "floated" as a complete disclosure of flotation! He also dwelt, somewhat at length, upon the lack of any disclosure of froth flotation in the prior art patents cited, classing Kirby, Froment, etc., as improvements upon the Elmore "bulk oil" process.

Mr. Williams resumed his argument on Monday noon, using nearly another hour of the allotted time in a discussion of the development made through the experiments of Mr. Higgins and leading to the discovery of the process of the patent in suit; he defied the defense to show that any one of the patents cited by the defendants had ever "arrived at the mill" or attained any practical results whatsoever.

Mr. Walter A. Scott, who made the entire argument for the defense, immediately followed Mr. Williams. Mr. Scott stated that all flotation processes fall into one of three distinct classes: (1) The Elmore bulk oil, or oil buoyancy flotation process; (2) the surface tension, or film or skin flotation process, and (3) the gas-oil flotation process.

He argued that the processes cited in the prior art, which do not fall into either of the first two classes on

account of their quantity of oil (1 ton of oil to 1 ton of ore being the minimum which will give bulk oil flotation), or on account of their nature of manipulation must of necessity fall into the third class, the class of the patent in suit. He argued that the Cattermole process itself was, by the testimony of the experts of the plaintiff, a two-stage process, the first stage being one of more or less violent agitation to thoroughly incorporate the oil in the ore pulp, and the second stage being a slow or rolling process, by which the minute oil-coated particles are rolled and formed into granules.

In support of his argument as to difference in result as due to agitation, Mr. Scott quoted Dr. Liebman, expert for plaintiff (the Minerals Separation), as saying, "I believe that 500 to 600 revolutions are quite sufficient for the Cattermole process. But I believe that at least 1200 revolutions per minute are necessary for the process of the patent in suit in the same apparatus." Mr. Scott also claimed that the word "floated" was properly, correctly and purposely used by Mrs. Everson to describe what actually took place.

Mr. Williams had argued that the effect of the agitation froth process was due to the reduction of the oil to the minute quantity of the process of the patent in suit.

Mr. Scott also pointed out that Judge Bradford had placed absolutely the distinction of the process from the other processes in the definite quantity of oil, in that Judge Bradford had sustained the first and the twelfth claims, and thrown out the ninth, which claimed a "small quantity" of oil, and that there must, therefore, be shown a difference in something more than degree.

In support of Mr. Scott's contention that it was the manipulation and not the definite proportion of oil to ore, and that the patent itself did not actually disclose how to use successfully this definite amount of oil, Mr. Scott quoted at length from the testimony of Mr. Nutter, the American technical manager for Minerals Separation, in his testimony as to how in practice he would determine how to adapt the process to a given ore, in saying: "I would try the following adjustments in my attempt to find proper conditions to produce flotation: (1) I would alter the rate of flow of pulp through the plant; (2) I would alter the speed of agitation; (3) I would alter the quantity, or (4) the kind of oil used; (5) I would alter the dilution of the solution circuit with reference to salts dissolved therein, and (6) I would vary the internal arrangement of the baffles or other diverging devices so as to affect the direction of flow of ore pulp." He thus quoted the plaintiff's own metallurgical manager as concurring in the opinion as to the effect of changes of manipulation, that it was "hard to say in advance, the effects are so various with different oils under different conditions."

This was possibly the climax of Mr. Scott's argument, which was clear and held the attention of the justices throughout. He then digressed to explain somewhat the British litigation, making possibly the impression upon the court that he would question the jurisdiction of the court over the case, since there was no disagreement, as he saw it, between the opinion of the Appellate Court and the British decision.

While the conditions under which one has a right to ask a hearing by the United States Supreme Court are definitely fixed, there is absolutely no restriction upon the court itself, and it can therefore review any decision of any United States court which in its discretion it may desire to review.

Mr. William Houston Kenyon made the closing argument in behalf of the plaintiff in the thirty-five minutes which remained of their time. One might have thought it hardly worth while even to attempt to say anything

[1]This journal, vol. XII, p. 362 (June, 1914).
[2]This journal, vol. XV, p. 441 (Oct. 15, 1916).

in so brief a time, by way of summing up a case on which so much could be said. But Mr. Kenyon literally turned the field glass around, and looking into the large end he presented a minute yet perfectly clear picture of the entire field. Not only did he review what previous counsel had said, as to the discovery of the process and its applicability, but he contrasted each of the prior art processes quoted by the defendant with the results of the process in suit, also claiming, as had Mr. Williams, that the prior art processes had produced no practical results and that there was nothing in the record in the case to show that their agitation froth had ever been produced or could be produced by those processes in the actual art, although admitting that in laboratory experiments "oil froths" could be obtained which were indistinguishable in appearance from the "air froths" of the patents in suit. He also found time to cite various decisions of the Supreme Court on parallel cases, and actually closed a moment or two before his thirty-five minutes had expired.

There was a very unusual and interesting feature in connection with this case. The Chief Justice announced, during the course of Mr. Scott's argument, that the members of the court would come to the Capitol Building at 10.30 on Wednesday morning to witness such demonstrations illustrative of argument as it might be necessary to make, but that attorneys were expected to make no argument during the performance of the demonstrations, only making such explanation as would be necessary to make clear what each demonstration was intended to represent.

The necessary apparatus was therefore assembled within the bar of the Supreme Court.

This demonstration, however, was not open to the public, only those connected with the case being expected to be present. Each side presented what it conceived as the apparatus of the prior art, the plaintiff to show the utter futility of the prior art processes, the defendant to show that there was no distinction, which was observable, between using the proportions of oil of the patent in suit and the use of larger quantities, even up to Kirby's 25 per cent of kerosene.

The results obtained in the presence of the members of the court were apparently so utterly contradictory that the Chief Justice requested that the plaintiff and defendant explain to the court how each accounted for the difference; an additional hour was granted for the purpose, half an hour for each side. The explanations were made by Mr. Williams and Mr. Scott for plaintiff and defendant respectively, Mr. Williams dividing his half hour into two, an opening and closing argument.

The argument of Mr. Williams was chiefly that the apparently successful results with quantities of oil in excess of those of the patent in suit were deceptive, that they were not in reality obtained with the air froths of the patent in suit, that they were mere laboratory tricks, possible only in the laboratory and having no utility whatever in the art.

Mr. Scott, on the other hand, contended that in performing the experiments, defendant had complied absolutely with the disclosures of the patents represented; that the patent in suit disclosed no greater violence of agitation than the prior art patents, the wording of which patents was possibly even more descriptive of violence of agitation than the patent in suit.

While this extra hour had been taken by the Chief Justice to discuss in court the difference of results of the experiments which had just been witnessed, it is remarkable that in this discussion the whole question of the suit was narrowed down to one point, and that is the point as to whether these experiments of defendant actually did or did not represent operations which it

would be possible, apart from the question of mere economy, to carry out upon a commercial scale in an actually operating plant.

Mr. Scott could not point to any testimony in the record of the Hyde case as to the use, upon an actual working scale, of these larger quantities of oil, although in reply to a question of one of the Associate Justices he said that there was such testimony in a parallel suit.

Mr. Williams, in his final closing of the case, referred to the testimony introduced by plaintiff as to the use of larger quantities of oil in plants of commercial size and stated that they got no results, that their attempts to use such larger quantities of oil were "absolute failures."

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From the above brief outline it is seen that apparently the plaintiff took definitely the position that the process of the patent in suit was the result of the reduced quantity of oil. In this connection we would call attention to our comments on Judge Bradford's decision in the Miami case, to the effect that imprejudiced investigators, mostly professors in our technical schools, who have studied flotation phenomena, have found no reason for discussing relative quantities of oil in their explanations of the causes of flotation. Is this a sin of omission on their part or is this distinction between different quantities of oil more of legal than engineering importance?

But here is the controlling patent, 835,120, for proportions of oil less than 1 per cent of the ore, before the deciding tribunal of the country, the United States Supreme Court, which court in its decision can consider only the evidence which was introduced in the Hyde record. The decision of Judge Bradford may be considered, but not the testimony contained in the record of the Miami case nor the great mass of literature on technical research which has appeared since the Miami trial.

Again, we might repeat what we had to say in connection with Judge Bradford's decision on the unsatisfactory basis of our whole patent law procedure.

Proposed Gasoline Specifications of Bureau of Mines

In direct response to the request of the General Supply Committee of the executive departments of the Federal Government in the District of Columbia for specifications to govern the purchase of gasoline in the District, the Bureau of Mines, Van H. Manning, Director, has prepared tentative specifications and has sent copies of them to the refiners, automobile engineers, jobbers, and other men prominent in the industry, with the request that the draft be criticized in order that when the specifications are finally issued they will be fair alike to the refiner and consumer. It is hoped that as a result of the consensus of opinion of all the interested parties specifications can be prepared that will be of value not only to the Federal Government in the District of Columbia, but to the entire public using gasoline for fuel purposes.

There is at the present time a considerable difference as to the grading of gasolines. The Bureau has attempted to grade gasolines, bearing in mind the principal motor purposes for which gasoline is used.

In the tentative specifications, the specific gravity test has been eliminated, as it is generally considered that specific gravity alone means little and is entirely inadequate, since it may give a high rating to a poor gasoline and a low rating to a good one. At present, the general tendency is to either specify tests which are unreliable, or else make requirements which are

unreasonably severe. Many buyers believe that only straight refinery gasoline, and not casinghead gasoline and cracked products, are desirable, and the test they require discriminates against a large portion of our market supply of gasoline.

The basic property which determines the grade and usefulness of a gasoline is volatility. It is not, however, a property whose influence may be stated concisely and in a few words. It is, of course, advantageous to have motor fuel vaporize easily. It is obvious that gasoline is not gasoline if it cannot be converted into an explosive gaseous mixture under conditions existing in the engine. These simple considerations would lead to the conclusion that the desirable product is one having a fairly high initial boiling point and a low end point. Here again, however, it is necessary to take account of further considerations which complicate the matter. The first is that a gasoline of narrow and selected boiling range is bound to be exceedingly expensive. In addition, it is not an unmixed advantage to have such a product. A high initial boiling point tends to make the engine in which such a product is used difficult to start in cold weather. It is also a question as to whether or not the low end point is an unmixed advantage. Some of the refiners of so-called blended products claim that the presence of the heavier naphthas causes the explosion in the engine cylinder to take place more slowly than in the case of lighter gasoline. The piston head is drawn through the same distance and the same power is developed, but the force is applied with a gradual push rather than with explosive violence.

It is claimed that this sort of action lessens the strain on the engine and actually tends toward greater power production.

These are claims for which as yet no conclusive experimental proof seems available. They seem, however, entirely plausible and are more than likely to receive credence because such products are bound to be used on account of cheapness.

In summing up the desirability of various degrees of volatility, it appears that it is desirable to have a certain percentage of fairly low-boiling constituents so that engines may start readily, but undesirable that such constituents should be present in too large proportion, on account of the resulting increased possibility of loss through evaporation and of accidental ignition and explosion. A reasonably low-end point is desirable in order to insure complete vaporization, but it makes the gasoline expensive. In addition, if it is possible to utilize high-end-point gasolines efficiently, it seems conceivably possible to develop maximum power with less strain on the engine. For these reasons, the end point should be as high as is possible, without exceeding a limit set by the ability of the engine to atomize and vaporize the gasoline properly. It is, of course, impossible to set limits which will meet all needs, but figures have been chosen which general use seems to indicate as most practical.

The analytical methods used for the testing of gasoline are of fairly recent development, but no adequate description of them appears to be available. Some of the tests employed are not standardized, and there are substantial differences in the methods by which they are conducted in various laboratories. There seems also to be a lack of knowledge regarding the practical interpretation of results obtained by analysis. The tendency is to overemphasize some particular figure. Formerly specific gravity was considered the complete index of the qualities of gasoline. At present a similar overemphasis is placed on the so-called "end point" of the Engler distillation. One of the chief objects of the proposed gasoline specifications is to indicate rationally methods of interpreting the analytical results.

At the present time there are sold in the market several grades of gasoline, these generally being classified according to their specific gravity, although the distinctive quality is that of volatility, the gasolines with low specific gravity and generally with low boiling range selling for the highest prices. Heavier grades are cheaper, and if properly used are capable of developing more power per unit volume than are the lighter gasolines. The Bureau of Mines has considered it advisable to divide gasoline into three classes, to be designated according to the maximum temperature limit (in degrees Centigrade) below which 90 or 95 per cent by volume must distill. Keeping in mind that the high-grade gasoline is to be used for special purposes, such as for aeroplanes, etc., and should include products of the type now sold in the Eastern market as of 70° Baumé or over. The middle grade is to be used for automobiles of a design of say, two years ago, and is represented by the type of gasoline now sold in the Eastern market, which ranges from 65 to 70° Baumé. The third grade, represented by the gasolines now sold in the Eastern market as around 60° Baumé gravity, is being used satisfactorily in up-to-date automobile engines. It is, of course, realized that the automobile engine has been improved so that it can use a heavier grade of fuel than was possible a few years ago.

The essentially desirable properties of gasoline may be stated briefly as follows:

(1) Neither the gasoline nor its products of combustion should have a strong or markedly disagreeable odor, this being objectionable to users of automobiles.

(2) The gasoline should be free from matter which is not hydro-carbon, such as water, sediment, acid, etc.

(3) The gasoline should be free from bodies which either originally or after combustion attack the metal composing the engine. Unremoved acid in refining and excessive sulphur content fall under this head.

(4) The gasoline should not contain excessive percentages of unsaturated or aromatic hydrocarbons, since some evidence is at hand which indicates that there may be limits in the ability of motors, as at present constructed and adjusted, to utilize these products.

(5) The gasoline should not contain too high a percentage of very volatile products which tend toward high evaporation losses and excessive danger in handling and storage.

(6) The gasoline should not contain any considerable percentages of heavy or non-volatile constituents which prevent the atomization into engine cylinders of a mixture which can be completely burned.

The above stated requirements are simple in principle and are almost axiomatic. The only problem is to fix limits, defined by experimental practice, which shall satisfy the desirable conditions.

There are at present on the market types of gasolines produced by several general refining methods. These may be classified as follows:

1. "Straight" refinery gasoline.
2. Blended casinghead gasoline.
3. Cracked and blended gasoline.

"STRAIGHT" REFINERY GASOLINES

"Straight" refinery gasolines are produced by methods which vary somewhat in different parts of the country, but are in general similar. Crude oil is distilled in a fire still and a cut made when the gravity of the product reaches some predetermined mark. The so-called crude naphtha or benzine is acid refined and then steam-distilled. In some cases several products of different ranges of volatility are produced, in others the

steam distillation simply effects a separation from less volatile bottoms which go into the burning oil stock.

"Straight" refinery gasolines are characterized by low content of unsaturated and aromatic hydrocarbons, and by a distillation range which is free from marked irregularities.

BLENDED CASINGHEAD GASOLINES

A product which has come on the market during the last few years is so-called casinghead gasoline which is produced from "wet" natural gas by processes of compression or absorption. "Straight" casinghead gasoline is too volatile for general use, and before being put on the market is blended with a sufficient proportion of heavy naphtha to produce a mixture which is both safe for use and moderately cheap. Blended casinghead gasolines are generally characterized by a volatility range showing considerable percentages of constituents boiling at both low and high temperature, but a deficiency of intermediate products. In some cases, however, the blending is done in such a manner that it is difficult to detect the natural-gas gasoline. This is when it is used in moderately small proportion to lighten and to make more volatile gasoline which has a boiling range approximately the same as that satisfactory for motor purposes.

As far as chemical properties are concerned casinghead gasoline seems to be identical with the "straight" refinery product. The characteristic properties are, therefore, wholly due to the details of blending.

CRACKED OR SYNTHETIC GASOLINE

One of the important factors in the present gasoline market is the production of cracked or synthetic gasolines. These are being marketed in enormous quantities largely, if not altogether, in the form of blends with "straight" refinery and casinghead gasoline.

Cracked gasolines are similar in physical properties to "straight" refinery products, but are different chemically in that they contain varying percentages of unsaturated and aromatic constituents. It has been demonstrated that these constituents do not decrease the value of a gasoline, if they are not present in too great proportion. It is still an open question whether or not motor fuel containing very high percentages of unsaturated compounds can be utilized in the same way as the "straight" refinery products.

Attention is also called to the fact that refiners are today marketing gasoline containing considerable percentages of unsaturated compound, and these products are being satisfactorily used by the public.

The Iron and Steel Market

The iron and steel trade is giving another exhibition of its ability to show kaleidoscopic changes. The outstanding feature of the general market, until quite recently, was simply the large amount by which steel prices advanced and the pressure that was exerted upon mills for deliveries. Pig iron attracted attention chiefly by reason of the fact that it had failed to advance by anything like a proportionate amount. With few exceptions finished steel products advanced simply in keeping with unfinished steel, so that the steel-making capacity was clearly seen as "the thin neck of the bottle."

The condition has now changed. Finished steel products have continued to advance, but the outstanding feature in the situation is the rapid advance in pig iron and the scarcity of coke.

A weighted average shows that pig iron has advanced about $5.20 in the four weeks ending at this writing, while almost one-half of this advance has occurred within the past week. The advance in the four weeks is almost equal to the total advance that had previously occurred, from the low point at the beginning of 1915.

The advance in pig iron is not fully understood, as to its causes and ultimate extent. About all that can be said, in general, is that it furnishes a fresh complication in the iron and steel situation.

Another change, kaleidoscopic in character, is that while hitherto the chief interest, as to tonnage production, has been in the physical capacity of the productive units and the rate at which new units might be completed, and the prospective supply of labor, the question engaging the most serious attention now is whether the transportation system of the country will be able to furnish adequate service for the continued operation of the productive capacity at its own physical limit.

Car Shortage

Car shortages have been steadily developing. At first the shortages were confined almost entirely to the coal mines. With an abnormally heavy demand for coal the mines were so poorly provided with cars that their output was decreased and shipments against regular contracts became less than consumers' requirements and less than the contracts called for. The steel mills and some other consumers bid for coal in the open market and prices for spot coal advanced to three or four prices. The highest price for Pittsburgh district mine-run, per net ton at mine, was about $6 for steam and about $6.50 for gas, while altogether a very considerable tonnage was sold at $5 and higher for steam, of $5.50 and higher for gas. Prices involved in long-term contracts are $1.25 to $1.35 and on annual contracts $1.30 to $1.50.

At the same time slight shortages of cars developed at Connellsville coke works, but in general the coke works were much better supplied than the coal mines. More recently car shortages for the shipment of finished steel have become serious, and while they have not thus far resulted in any widespread congestion of steel awaiting shipment from mill it has been only by careful management that congestion has been avoided. With the majority of finished steel products there are no facilities at mill for the storage of any considerable tonnage. In the case of tin plate, sheets, wire products and pipe large warehouse facilities are part of the regular equipment, but even then the double handling is expensive, and cannot conveniently be compassed at this time when labor is so scarce. In bars, plates and shapes the storage facilities are relatively limited. Plates are the most awkward commodity, and it is for plates that there is the heaviest demand.

A very tense condition has resulted, the flow of raw, semi-finished and finished material being conducted with much difficulty. This condition has arisen under very favorable weather conditions, while it is practically certain that bad weather will come within a very few weeks. Even when the railroads are working at their best the first cold snap slows down their operations. At present the railroads are working under high tension, with insufficient motive power and with many locomotives kept out of repair shop through no merit of their own, but because they cannot be spared. In cold weather they may not go at all. It is felt in the steel industry that there is a strong balance of probability that cold weather will result in a general railroad blockade of such extent as to curtail the production of iron and steel, and production may be curtailed all along the line.

October outputs were exceptionally good, partly because the weather was, as usual in October, especially favorable, and partly because mill managers and heads of departments have gotten into the habit of grooming their equipment and arranging matters generally so as to make a record in October. The Carnegie Steel Company produced 970,000 gross tons of ingots in the month, a new record, its objective point having been 1,000,000 tons. Many mills made new records, which may be heard of when there is time to discuss such trivial matters. The production of pig iron in the industry as a whole averaged 41,700,000 tons per annum, against only a 38,100,000-ton rate in August and a previous maximum rate of 39,800,000 tons, last May. It is doubtful whether a 40,000,000-ton rate can be averaged in the remainder of the year.

Pig Iron and Steel

At this writing basic pig iron at valley furnaces is $25 and Bessemer $29, against $12.50 and $13.60 at the low points early in 1915. Billets are $50 to $55, against a trifle less than $19 at the low point. Thus pig iron has much room for an advance if there is pressure for pig iron to keep the steel works in full operation. Apart from transportation difficulties the most serious menace to full pig-iron production is the coke situation. Connellsville furnace coke, for which there are contracts in force, for the present half-year, at $2.25 to $2.75 per net ton, f.o.b. ovens, has brought $7 to $8 during the past few weeks, for spot shipment, the price representing the urgency of some consumers for coke in addition to that supplied on their contracts. The merchant furnaces, with pig iron to deliver under contract at a profit of $2 to $3 with their raw materials at contract prices, cannot afford to pay such prices, while to the steel mill the price is no deterrent.

Finished steel products continue to show an advancing tendency. Regular mill prices are supposed to be 2.70c. on bars, 2.80c. on shapes and 3.25c. on plates, but these prices have become largely nominal. In the first half of November wire products have been regularly advanced $3 a ton and sheets have advanced about $5 a ton. Steel boiler tubes have been advanced two points or about $4 a ton, and lap-weld iron and steel pipe has been advanced one point. The American Sheet & Tin Plate Company on Nov. 6 withdrew from the tin-plate market, being practically sold up. It was only on Oct. 12 that it entered the market, for the first quarter of 1917 in the case of jobbers, and for the first half in the case of manufacturing consumers.

The Steel Corporation's unfilled obligations at the end of October, as announced on Nov. 10, amounted to 10,015,260 tons, a new record. The increase during October was 492,676 tons, the largest increase for a month since last April. The increase amounted to about 39 per cent of normal capacity for the month, while shipments may be estimated at 106 per cent of normal capacity, indicating bookings at 145 per cent of capacity. The bookings were largely in sheets and tin plates, in which business for several months' delivery was crowded into the one month, while there was also a large volume of car and ship material. After several months of very light buying the railroads contracted for about 20,000 freight cars in September and about 32,000 in October.

Non-Ferrous Metal Market

Nov. 10—The election brought most of the metal markets to a standstill, temporarily, awaiting the result. Copper is higher with a scarcity of metal existing. Tin is firm with little business doing. Lead is quiet owing to the election uncertainty. Spelter is higher in an unsettled but active market.

Copper.—The market is in a strong position with offerings very small for November and December delivery. A rumor is abroad that England is in the market for 200,000,000 lb. for shipment over the second half of 1917 but no confirmation of the report has come yet. The demand for home consumption is good, with spot electrolytic at 31.00 cents. First quarter is offered at 29.00 to 29.50 and second quarter at 28.50 to 29.00. According to the American Metal Market Report there is no large inquiry for 1916 shipment that cannot be filled from resale lots or from consumer's offerings. Exports for October were 32,712 tons. Exports for ten months ending Oct. 31, were 277,930 tons, which compares with 276,344 tons exported in 1915.

Tin.—The tin market remains firm in spite of a very small buying movement. Spot Straits tin is held at 43.00 cents. There is not much future tin offered, on account of the reported strong market abroad, sellers preferring to wait. The tin situation as it stands at present appears to be that there is a large demand and the supply is not sufficient to take care of it. Arrivals so far this month are only 300 tons but there is over 4000 tons afloat and due by Nov. 20 on various steamers. Arrivals in October were 2655 tons, considerably below the average.

Lead.—The lead market is dull both here and abroad, with the Trust price still 7.00 cents at New York for early deliveries. Independents ask 7.12½. Exports so far this month are 678 tons. Exports in October were 4609 tons.

Spelter.—Prices are higher and have risen steadily the last few days. An unsettled condition prevailed during the election period and little business was done. For November delivery 11.25c. is asked. For December 11.12½c. is asked. First quarter is quoted at 10.75 to 11.00 and second quarter at 10.50. Exports up to No. 8 were 2861 tons.

Other Metals.—*Silver* is up to 71⅞, which is the highest price since last May. *Magnesium* is held at $3.50 per lb., electrolytic *nickel* at 55 cents, cadmium at $1.50 per lb. *Quicksilver* is quoted at $80.00 per flask and *platinum* at $95.00 per oz. *Aluminium* is offered at 66.00 cents for No. 1 virgin metal. *Antimony* is quoted at 12.87½ to 13.12½.

Coming Meetings and Events

American Mining Congress, Hotel LaSalle, Chicago, Nov. 13-18.

Society of Chemical Industry, New York Section, New York, Nov. 24.

American Society of Mechanical Engineers, New York, Dec. 5-8.

American Association for the Advancement of Science meets with American Chemical Society and also with the four national engineering societies represented at the Engineering Societies Building, New York, Christmas week, 1916.

American Institute of Chemical Engineers, New York, Jan. 10-13, 1917.

Chemistry and the Gas Industry.—The joint meeting of the New York Section of the American Electrochemical Society and of the Illuminating Engineering Society on Nov. 9 was very interesting. Two papers were presented, one by W. R. Addicks on gas standards, the other by Elmer L. Knoedler on the chemistry of the new flexible mantle. The papers elicited an interesting discussion. W. Greeley Hoyt presided. An account of the proceedings and of the papers and discussions is reserved for our next issue.

The Chemist in Public Service

A meeting of the New York section of the American Chemical Society was held on Friday evening, Nov. 10, at the Chemists' Club, at which the general subject of "The Chemist in Public Service" was discussed in four very interesting papers. It was the consensus of opinion that the highest ability is required in Government, State and City service, but that the compensations provided are inadequate and do not attract the best men.

Prof. CHARLES A. BEARD of Columbia University, gave his views on the general problem of public service training. He said there are nearly 2,000,000 employees in the service of the Government, States, and Municipalities, with between 80,000 and 90,000 in New York City. The great increase in the number of our Government employees has been caused by our enormous industrial activity. Professor Beard thinks the most serious problem is to educate the public into realizing that Government employees must be trained scientific men.

Prof. FREDERICK E. BREITHUT of the College of the City of New York, presented some very interesting tables gathered from authoritative sources at Washington, showing the number, titles and compensation received by chemists in the Federal Service. Similar tables for State and City service were presented. In the Federal service there are 716 chemists with 71 distinct titles which cost the Government $1,500,000 per year. Seventy-five per cent of all chemists in Federal State and City service get salaries ranging from $1,000 to $2,500. Professor Breithut recommended that a committee be appointed by the society to determine the status and compensation of the chemist in public service in order to raise the standard.

Dr. OTTO H. KLEIN, director of the Central Testing Laboratory, New York City, gave an interesting outline of the work of his laboratory in testing materials purchased by the city. He was in favor of more adequate compensation.

Dr. HARVEY W. WILEY gave a very interesting and witty talk, in which he recited some of his experiences in the Bureau of Chemistry of the Department of Agriculture, of which he was one of the first four members and was chief chemist for many years. He said there are three kinds of chemists in public service, viz., the routine chemist, the research chemist, and the executive chemist. Research is an important part of the Government chemists' work.

The Western Metallurgical Field

Mills

The **Hartford Mining Co.** is remodeling a 300-ton mill, formerly located near the Empire Zinc Co.'s ground near Galena, Mo. The contract for the remodeling of the mill has been let and work is to start immediately. The mill will be made modern throughout with well-equipped jigs and sludge tables to handle the fine ore. The three shafts will be connected to the mill hopper by incline tramways. A huge hopper will be employed to feed dirt to the mill. This new mill will have a daily capacity of 400 tons. The same company also has producing mines at Cave Springs and operates a 300-ton mill in this locality which in the last week of September turned in 133,460 pounds of blende and 15,200 pounds of lead.

The **Eaglewood Mining Co.**, located near Bellville, Mo., is erecting a new 250-ton mill to handle rich dirt. The mill will be of the most modern type and it is expected will start operation on the first of November.

Recently the mill of the **Prince Consolidated** was completed. The mill is located a mile and one-half from the station of Panaca, Nev. It is being built on the old smelter site at the former camp of Bullionville. A description of this mill was given by C. F. Sherwood in the Salt Lake Mining Review, an extract of which may prove of interest. The mill has in view the treatment of the Bullionville and Dry Valley tailings, which are situated approximately half a mile from the station of Panaca. The tailings are over 40 years old and are the results from old mining practice. Most of these tailings have been retreated by amalgamation and cyanidation. The Day Valley tailings are identical with the Bullionville tailings and are shipped to the mill. All these tailings are highly siliceous and entirely oxidized. The values contained are: Lead, 8.2 per cent; silver, 11 ounces, and gold to the extent of $1.40. Due to the fact that the lead is contained as carbonate and the silver as chloride, a gravity separation of such an ore would give low results. The most economical method for concentration was found to be the sulphidizing of the lead carbonate with a sulphide film by means of sodium sulphide and then floating the lead off.

The Mill Flow.—By means of a 30 x 10-ft. thickener, the tailings are collected at the head of the mill. The thickener is supplied from the pit by means of a 2-in. compound sand and slime pump. The thickener at the same time acts as a regulator for the supply of tailings to the mill. The underflow from the thickener enters a 5 x 16-ft. tube mill, which contains a load of 6 tons of manganoid spheres. The discharge from the tube mill flows to two 14 x 6-ft. underfed agitators. These latter have proved unsuccessful due to the large amount of sand treated and are being replaced by mechanical agitators. The sodium sulphide solution is added to the pulp at the discharge from the tube mill, and the active sulphidizing lasts at least 30 minutes after leaving the agitators. From here the pulp passes to an elevator, where the oil is added, and is emptied into two 4 x 18½-ft. pachuca tanks, which operate under a pressure of 30 pounds. The pachuca tanks act as emulsifiers. These tanks discharge directly into a series of six roughing cells, the concentrates being broken up by a water spray and a belt elevator and are cleaned in one cleaning cell. The tailings are returned to the feed of the pachucas. The concentrates are thickened in a 16-ft. thickener and filtered by means of an 8 x 6-ft. continuous filter. The tailings from the roughing operations are classified, the slime overflow from the classifier being pumped to a 2 x 8-ft. pachuca tank, where a small amount of oil is added and refloatation takes place. The regular concentrates from this operation are cleaned in a half size cleaning cell; concentrates from this cell joining the rougher concentrates from the first series, the tailings from the cleaner returning to the small pachuca for retreatment. The tailings from the second series rougher are sent to waste. The discharge from the classifiers is tabled on four slime tables, the concentrates going to the concentrate thickener running also on the clean flotation concentrates. The middlings are returned to the head end of the mill for retreatment and the tailings go to waste.

Nickel

In the past, the main nickel supply came to this country from the Sudburry district of Canada. From a metallurgical standpoint it is therefore interesting to know that nickel-bearing ore deposits of considerable extent have been located in California. According to Bulletin 640-B, U. S. Geol. Survey, 1916, this nickel deposit is the property of the **Friday Copper**

Mining Co., located about four miles south of Julian, a village 60 miles northeast of San Diego, Cal.

The ore of the Friday property is mainly pyrrhotite, but also contains pyrite, chalcopyrite and an iron-nickel sulphide. The ore is accompanied by small amounts of amphibole and a carbonate, which in all probability is calcite. The pyrrhotite in this ore possesses an unusually perfect cleavage, a parting of which shows that some of the individual crystals have a diameter of 2 in. The pyrite forms a network through the ore and is present to an extent exceeding 10 per cent. Much smaller in amount is the chalcopyrite and a smoothly polished white mineral, which on analysis proved it to be an iron-nickel sulphide, the crystalline form of which could not be accurately determined. The mineral is not pentlandite, as it does not possess the characteristic brownish-yellow tint. As it is free from arsenic it cannot be gersdorffite. In all probability the mineral is polydymite Ni_3S_4 with part of the nickel replaced by iron, giving the formula $Ni_2Fe_2S_5$.

The cupriferous and nickeliferous sulphides occur, for the most part, in contact with one another, forming irregular bodies about 5 millimeters in maximum diameter. The supposed polydymite also forms small veins, which cut the pyrrhotite but not the pyrite. This phenomenon suggests that the cupriferous and nickeliferous sulphides are very nearly contemporaneous and older than the pyrrhotite, while the pyrite undoubtedly is the latest of the sulphides.

If these deposits occur in large enough amounts, and if the average nickel content justifies an economical treatment, there will be an opportunity given to the metallurgist to apply the newest methods of concentration for a satisfactory separation of the various sulphides from each other.

Current News and Notes

Production of Primary Spelter, Jan. 1 to June 30, 1916.—The table below is taken from the Press Bulletin of the U. S. Geological Survey, No. 285, Aug. 16, 1916, and gives the statistics from 1912 to 1916 by six-month periods:

Another table of interest is the one on page 6 in the same bulletin, giving the active zinc smelters in the United States and their capacity for 1916.

Contract Reform in the Glass Industry.—A committee of the National Glass Distributors' Association recently held a meeting in Pittsburgh with manufacturers of plate, window and wire glass for the purpose of discussing a proposed new contract similar to that adopted by the National Association of Sheet and Tinplate Manufacturers, which eliminates conditions or provisions guaranteeing prices against market declines. A further investigation will be made before taking any definite action.

The **Milwaukee Engineers' Club,** which includes in its membership members of the American Society of Mechanical Engineers, American Institute of Electrical Engineers and American Chemical Society, held a meeting recently in the new engineering building of the Federal Rubber Company, Cudahy, Wisconsin. Mr. L. J. D. Healy, chief chemist of the company, read a paper on "The Growing and Gathering of Rubber Latex."

Welfare and Efficiency Conferences—The Fourth Annual Welfare and Efficiency Conference of the State of Pennsylvania will be held in the House of Representatives at Harrisburg, on November 21, 22 and 23. The meetings are held for the purpose of improving relations between employers and employees, and to discuss safety and welfare work. The arrangements are in the hands of the Department of Labor and Industry.

Alcohol.—An order for 30,000,000 gallons of alcohol was reported to have been received the first week in November by the United States Industrial Alcohol Co. from a large powder manufacturer. The order involves practically $10,000,000. The large domestic demand for alcohol has greatly curtailed our exports, and the shortage has been keenly felt abroad.

The **Nordberg Mfg. Co.,** of Milwaukee, Wis., announces the appointment of Mr. H. W. Dow as sales manager. Mr. Dow has been associated with the Nordberg Mfg. Co. in the engineering and sales departments for 12 years. The Nordberg Mfg. Co. build steam and electric hoists, Corliss engines, poppet valve engines, uniflow engines, air compressors, oil engines and the Nordberg-Carels Diesel engines.

SPELTER STATISTICS, 1912-1916, BY SIX-MONTH PERIODS (In Tons of 2,000 Pounds)

	1912		1913		1914		1915		1916
	First Half	Last Half	First Half	Last Half	First Half	Last Half	First Half	Last Half	First Half
Supply:									
Stock at beginning	9,081	6,414	4,522	21,856	40,659	64,039	20,095	5,884	14,253
Production—									
From domestic ore	159,952	163,955	171,135	166,117	171,496	171,922	207,634	250,501	267,696
From foreign ore	6,544	8,355	9,078	346	3,562	6,069	8,898	22,486	48,756
Imports	3,053	8,062	5,533	567	506	374	489	415	464
Total available	178,630	186,786	190,268	188,886	216,223	242,404	237,116	279,286	331,169
Withdrawn:									
Foreign exports	7,331	174	8,724	4,672	2,048	8,513	5,959	8,016	20,197
Domestic exports	5,839	795	6,615	1,168	824	63,983	64,368	54,235	58,007
Stock at close	6,414	4,522	21,856	40,659	64,039	20,095	5,884	14,253	23,879
Total withdrawn	19,584	5,491	37,195	46,499	66,911	92,591	76,211	76,504	102,083
Apparent consumption	159,046	181,295	153,073	132,387	149,312	149,813	160,905	202,782	229,086
Spelter made in—									
Illinois	44,224	44,173	53,524	53,130	62,062	65,884	74,982	84,976	90,082
Kansas	52,485	48,619	42,645	31,461	23,737	20,773	35,247	66,176	74,592
Oklahoma	36,010	40,915	43,253	39,961	45,443	45,924	51,172	58,036	73,298
All other States	33,777	38,603	40,791	41,911	43,816	45,410	55,131	63,799	78,480
	166,496	172,310	180,213	166,463	175,058	177,991	216,532	272,987	316,452
Zinc ore imported	27,049	16,891	19,994	11,422	9,052	22,910	66,683	92,169	231,845
Zinc content	12,228	5,339	9,204	4,293	2,949	9,183	23,997	33,672	93,907
Zinc ore exported	13,709	9,640	9,745	7,968	8,042	3,069	678	154	34

*"Primary spelter," which is produced directly from ore, is here distinguished from "secondary spelter," which is obtained by refining zinc ashes, drosses, and old metals.

Guayule and Industrial Preparedness

By Andrew H. King

Every patriotic American believes in preparedness, both for war and for peace. We realize that the nation best prepared for peace is also best prepared for war. As has been said, modern warfare is fought by machinists and chemists, not at the front, but in the factories. Broadly speaking then, war of nations is a contest between their industries.

Industrial preparedness means simply the co-ordination and co-operation of American industries. It does not mean consolidation, but simply friendly, mutual assistance. There will be no stock jobbing profits to distribute. Remarkable as it seems, the idea is to raise our industries to the highest efficiency possible, and what is more remarkable, to increase the quality of the products. The more nearly a country is self-contained and self-supporting, the safer it is from invasion, and the stronger it is in war. Germany is an extraordinary example of industrial preparedness. She has been cursed with militarism, but blessed by industrialism. The first drew her into war, and the second will get her out of it. For two years she has been practically shut off from the rest of the world, yet she has supported herself and kept the war beyond her borders.

True industrial preparedness demands a plentiful supply of all necessary raw materials. But two have furnished real problems in Germany. Copper had to be requisitioned from all parts of the empire. Even the bells had to be melted down. All this material was a potential resource and could be recovered. Rubber was a different proposition, since reclaiming always decreases the quality. While it is probable that a considerable supply of crude rubber was laid by in anticipation of the blockade, it is quite certain that this quantity proved insufficient, and that a decided rubber famine now prevails in Germany. By latest accounts, fine Para is selling for about $15 per pound in Berlin. We are paying a little less than 90 cents for the same rubber.

I hardly think it necessary to outline the part rubber plays in modern warfare, but I will mention a few of the most important instances. The part that motor trucks play is well known, they have taken the place formerly occupied by endless mule teams. The ammunition, food, and other necessaries are all carried from the base of supplies to the front by trucks. Huge motor lorries carry whole companies of men to threatened points, in an infinitely shorter space of time than they could possibly "double quick" it. Wherever we have motor conveyances we must have rubber tires. Safety, speed, and comfort demand it.

Then the men in the trenches must be protected against the weather. They must sometimes stand for hours waist deep in water. It has been said that the rigors of army life killed more men than the bullets in our Civil War. A great civilian army cannot be expected to withstand such hardships. England knows this, and her soldiers are protected by suitable rubber coats and capes, and they wear high hip boots in the trenches. The underground bomb-proof shelters are sometimes lined with regular ground sheets. These are squares of rubber coated cloth which the soldiers place on the floor of their tents to keep out the dampness.

The list can be prolonged almost indefinitely. When a country does not have enough rubber to properly care for her men at the front, what must be the condition of the people left at home? What will they do for fire hose, rubber gloves, etc.? Their need will be just as great, if not greater, than that of the soldiers.

"Safety First," which is but another name for "Industrial Preparedness," demands that we make such a predicament impossible. A recent poll of the country has shown that our rubber companies are quite capable of handling any emergency which may arise, *provided* their supply of crude rubber be not interfered with. Such interference would depend considerably on whom our enemies might be. Under present plans outlined by the last Congress, our navy is to be made second-best in the world. It is not considered worth the effort to try to surpass Great Britain. It is believed that there will never again be war between English speaking nations. Nevertheless, such a calamity is quite possible, and should this ever happen we would be barred from the seas just as effectively as is Germany at present. In any case, ships bearing rubber to our shores would be in constant danger, and without doubt the supply would be considerably decreased, if not completely cut off.

The best way to prevent such a situation is to build up in this country a strong, profitable, crude rubber business; which would be a valuable resource, a source of protection in time of war, and a source of wealth in time of peace. It would require no special protective duties to give it a start, but only brains and capital.

It has been suggested at numerous times that the Philippine Islands is a suitable location for an American plantation industry. Conditions there are quite favorable, but it would still mean ocean transportation, which, as has been stated, would be dangerous. Besides, some rather thoughtless parties in Congress seem about ready to set the Islands adrift. They seem to forget that American lives and money were spent in acquiring them, and now that the American people are soon to reap what they have sown, they bring up the old cry of imperialism and say "Set them free!" This country needs a tropical colony and now that the Philippine Islands are becoming a safe place for a white man to live in, they should be developed. But until the matter is definitely decided, it is not a good policy to invest much American capital there.

We have a good example of such a situation in Mexico, where some billions of dollars have been invested. How much of this sum still remains we do not know, but we are quite certain that it is earning next to nothing, and that means loss enough. Our statesmen and our capitalists should learn a lesson from the British and always, with rare exception, keep American money under the American flag. This is but another instance of "Safety First."

In 1915 the world's production of crude rubber was in round numbers 146,000 tons. Of this amount 96,000 tons were Plantation Para; 37,000 tons Wild Para, and Caucho; and all other rubbers, no matter from what source, made up only 13,000 tons. About 100,000 tons, or 68½ per cent, were shipped from British possessions in the East Indies. South America supplied only about 38,000 tons, or 26 per cent. The other 5½ per cent, which amounts to 8000 tons, came from Africa, Mexico, and several Dutch colonies. Late in 1914 Great Britain declared an embargo on all shipments of rubber from any point in the Empire, which was to take effect early in 1915. Obviously to have 68½ per cent of the world's supply cut off, would cause considerable hardship. Diplomatic negotiations were futile, and only by the acceptance of every condition demanded by England was the Rubber Club of America able to have the embargo lifted. We were given a taste of conditions such as Holland has had to endure in all her imports.

American plantations would act as a stabilizer. Any unreasonable demands would be balanced by an increase in home production. It is said on very good authority that washed and dried plantation smoked sheets can be laid down in New York at a profit at 25c. per pound. Evidently the planters are reaping something

of a harvest. Taking an average price of 88c. per pound, the profit must be something like 63c. or 250 per cent over and above the net cost. Since America uses around 60 per cent of the world's production, it is evident that we are paying too high a price for rubber. From the standpoint of economics this money should stay in the country.

Of all rubber-producing plants, only Guayule grows wild within our borders. In the Big Ben territory in Texas a large district, only second in size to the Chihuahuan field in Mexico, is available. Why not extend this field over the arid lands of New Mexico, Arizona, and Nevada? Waste land would be utilized, and a valuable product secured.

Guayule is not new to the American rubber man, unfortunately it is almost ancient history to him. It is safe to say that there are scattered over this country at least fifty abandoned deresinating plants, intended primarily for the treatment of this rubber. At one time they furnished about one-fifth of the entire rubber used in this country. The total production of the Mexican Guayule fields was about 10,000 tons of the washed and dried, but not deresinated, rubber per year, from 1905 to 1910. In 1911 it began to fall off, and the recorded production for 1912 is 3500 tons. About 80 per cent of this production was exported to the United States. Since 1912 Guayule has been comparatively unimportant.

This decline was brought about by internal conditions in Mexico, and by wasteful methods of harvesting. Since 1911 revolution after revolution has swept over that country, and conditions have gone from bad to worse until every legitimate industry is at a standstill. All peaceful industries are the prey of roving bands, who hold which ever allegiance seems most advantageous to themselves; bands of thieves, lead by men without principle, without patriotism, without honor; bandits who must be destroyed before peace can come.

Guayule was first discovered by J. M. Bigelow, M.D., in 1852, near Escondido Creek, Texas. While attached to the Mexican Boundary Survey he noticed the shrub, which the natives were in the habit of burning. On account of the high resin content, it burns like fat pine, and was highly valued for fuel. Through him, Prof. Asa Gray of Harvard obtained a sample, and he was the first to give it a botannical description. A part of this description follows:

"*Parthenium argentatum*, a well marked species connecting the sections Argyrochaeta and Parthenichaeta; the leaves and branches whitened by a very fine and close silk-silvery pubescence, which appears to be wholly or nearly persistent. Leaves 1 to 2 in. long, including the tapering base and petiole; 2 to 5 lines wide, mostly acute, scarcely veined, beset on each margin with from 1 to 3 salient teeth, or sharp lobes. Flowering branchlets, slender, 4 to 8 in. long, nearly leafless and peduncle like, bearing 3 to 7 subsessile heads in a cluster."

The name Guayule is properly applied only to *Parthenium argentatum*, Gray. There are certain other plants of related species that closely resemble it, which led to

considerable over-estimation in the early surveys. The botanical name refers to the silvery luster of the leaves, due to closely set air containing hairs on the surface.

The plant is peculiar to the Chihuahuan desert, and is found principally in the northern portion of the Central Plateau. The area is close to 130,000 square miles, not all of which carries guayule. Endlich (1905) estimated the actual shrub-bearing region as about 34,000 square miles. Lloyd, "Guayule," 1911, bounds the region as follows:

"From the western extremity of Presidio County, Tex., the western boundary runs somewhat west of south, till it reaches the northern boundary of Durango, near Santa Barbara, Chihuahua. From this point the line turns approximately toward the southeast, running parallel with the Mexican Central Railway at a distance of about 100 kilometers. Beyond the State of Durango, the boundary turns still further to the east, curving northward again not far from the City of San Luis Potosi. The 101st meridian marks roughly the eastern boundary, lying somewhat west of it till beyond Saltillo, where the boundary then curves slightly west of north, reaching the eastern limit in Texas at about Langtry. The northern limit is marked approximately by Ft. Stockton."

This area has an altitude of from 2000 to 10,000 ft. above sea level, but most of the acreage will be found around 6000 ft. Unlike Hevea, guayule can withstand comparatively low temperatures. Records have shown it to stand a temperature of 5 deg. Fahr. at Marathon, Tex., and of 10 deg. Fahr. at Tucson, Ariz. Very little rainfall is necessary since the plant seems to thrive in districts where the annual rainfall is around 10 in., but the growth of the plant is proportionate to the precipitation. Irrigation has been recommended, and wherever tried has given excellent results. The plant grows during the rainy season, and the transformation to rubber takes place during the dry time. A rocky, calcareous soil is most favorable. From these data it is evident that the guayule shrub is quite hardy, and its cultivation should not be nearly as difficult as that of Hevea Brasiliensis.

It is quite true that the problem presents radically different angles. For one thing, *Parthenium argentatum* is a weed, and seems to be as perverse as most weeds. Up to 1911 Lloyd writes that the facts had not warranted cultural trials on a scale sufficient to make available a crop of anything but limited experimental size. Since then about all the guayule on the market has come from Texas, and experimental planting seems

FIG. 1—GUAYULE SHRUB

to have discontinued. The nonsuccess may be due to over-cultivation rather than the lack of it.

By the application of the principles of forestry, the supply of the shrub can be greatly conserved. For a long time it was customary to pull the plants up by the roots, instead of cutting them off level with the ground so that new shoots might be sent up in the next growing season. It was also general practice to pull up all plants regardless of size. This was a serious mistake, and later the harvesters restricted themselves to plants of at least 16 in. in height. Five years later another crop of 16-in. plants would be available. Fifteen years is regarded as the rotation period, and the maximum economic efficiency is reached when the plant attains a height of from 12 to 16 in. Fig. 1 is a fair example of a full-sized shrub. In 1905 Endlich estimated that the total supply was not much greater than 37,500 tons of shrub. This estimate proved quite conservative, but in 1911 various observers agreed that about four-fifths of the original supply had been gathered.

Parthenium argentatum is remarkable among all rubber producing plants in that caoutchouc occurs as such
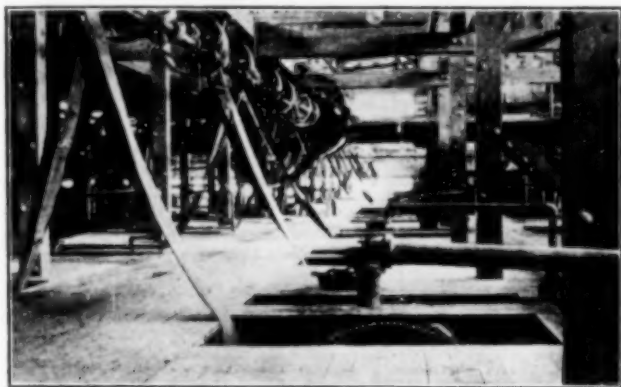
FIG. 2—CHARGING FLOOR OF GUAYULE FACTORY

in the plant structure. In *Hevea Brasiliensis*, it is present in colloidal suspension in the latex. The rubber content of the different parts of the shrub, as given by Whittelsey, is as follows:

Trunk bark	21.4 per cent
Root bark	19.5 per cent
Branches and leaves	9.7 per cent
Trunk wood	0.0 per cent
Root wood	2.0 per cent

Based on perfectly dry material, the percentage of rubber in the whole trunk is 9.9, the whole root 7.8, the leaves and branches 9.7, and in the whole plant 9.5. If mill weight is taken as a basis, the percentage of rubber on the whole plant is 7.8, which figure is very close to that gained in factory experience.

Since the rubber is contained in a cell structure, and will not escape by bleeding, certain methods of extraction are necessary. Three methods have been used with more or less success; they are as follows:

1. *By means of solvents:* The shrub is given a preliminary washing and grinding, and is then treated with a mixture of acetone and gasoline, which dissolves out the rubber and the resin. On filtering this solution any sticks or pieces of stone are removed. By increasing the acetone content in the solution, the rubber is precipitated out in practically the deresinated state. This process never had a very wide application, principally because the factory would have to be located in Mexico or Texas, and cold water, which is of prime importance to every deresinating plant, is not there available in sufficient quantity.

FIG. 3—DISCHARGE ARRANGEMENT FROM MILLS

2. *By chemical methods:* Caustic soda has been used to attack the cell walls. The principle is quite similar to that of alkali process reclaiming. In this case the wood fibers, *i.e.*, cellulose, are hydrolized, and the rubber set free. In addition to removing the wood, a portion of the contained resin is also rendered soluble. This resin content varies from 23 to 28 per cent, and is, according to Hinrichsen, 78.2 per cent unsaponifiable. In this manner the resin content is cut down to about 18 to 23 per cent. These figures are based on the washed and dried rubber. The chief difficulty with this process is in washing out the last traces of alkali, which will act as an unregulated accelerator, and the rubber is quite liable to harden up on aging.

3. *By mechanical means:* By far the largest proportion has been produced by this process. The plants are first thoroughly washed so as to remove any dirt or dust, which in subsequent stages would be attached to the rubber. They are then given a medium coarse grinding between corrugated rolls. The resulting mass is transferred to a ball or pebble mill, where it is ground to a pulp. The customary charge is as follows: One-third of its volume of pebbles, one-half of water and about 6 to 8 bushels of shrub. The mill is rotated at about 30 r.p.m., and the grinding time is from ninety minutes to two hours, depending on the quality of the plants. The dirty water is drained off and the pulp run into tanks, where the rubber, carrying considerable wood, floats, and is skimmed off, This is the first separation.

It is further purified by completely waterlogging the ground wood by subjecting it under water to a pressure of over 200 lb. for sometimes as long as two hours, after which it is run into a beater, which greatly re-
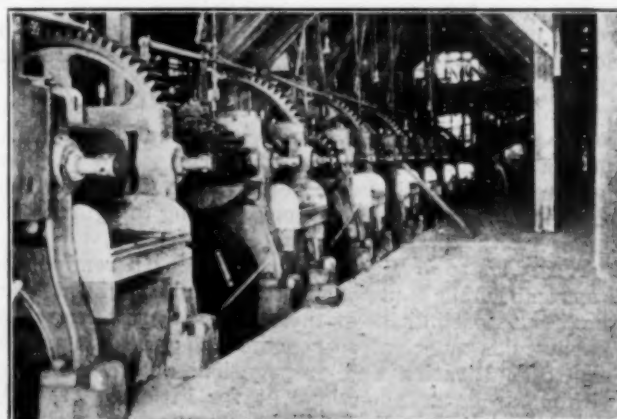
FIG. 4—GROUP OF WASHING AND SHEETING MILLS

sembles those in use in the paper mills. This pulp is run into settling tanks, where the wood and some of the rubber, called sinkers, or bagasse, settles. The remainder, which floats, is separated by skimming. Sinkers amount to about one-twelfth or 8.33 per cent of the rubber content.

U. S. Patent 979,902, Jan. 8, 1910, to H. T. G. Van der Linde, is for a method of recovery of this loss. The wood fiber, sinkers, etc., are dried either by compression or heat to the consistency of wet sawdust, after which they are treated in a pebble mill with ¾ gal. gasoline per 100 lb. In a short time the rubber swells, and when again thrown in the settling tanks it rises and is skimmed off.

Instead of waterlogging under pressure, as above mentioned, it is sometimes customary to let the pulp soak for a couple of weeks in water. This treatment is said to give better aging properties.

Fig. 2 is a photograph of the charging floor of a guayule factory, from which the pebble mills are filled. Fig. 3 shows the discharge arrangements from these mills, and Fig. 4 a group of washing and sheeting mills.

The skimmed rubber is given a thorough washing on regular rubber washing rolls, from which it is sheeted preparatory to vacuum drying. Formerly guayule was shipped out with as high as 25 per cent moisture present. It is now all well dried, and bacterial action is thereby greatly retarded.

Commercial guayule contains about 75 per cent of rubber hydrocarbons, and does not differ from Highland Fine Para by any greater extent than do other second-class rubbers. On distillation with steam it yields from ½ to 4 per cent of a volatile oil, which is lævo-rotatory and possesses a peculiar and quite distinctive pepper-like aroma. This oil was shown (P. Alexander, Ber, 1911, 4, 2320-2328) to consist mainly of lævo-pinene and sesquiterpene. If not removed it is liable to cause serious trouble on vulcanization of the rubber.

The high resin content is also detrimental, since the resins not only combine with sulphur, but exert a solvent action upon the rubber at the temperature of vulcanization.

But when they have been reduced by extraction to 2 or 3 per cent no difficulty is encountered and the rubber is comparable to Brown Crepe. It does, however, require slightly more sulphur than plantation rubbers, and it is customary in compounding to figure about 7 per cent sulphur on the rubber content.

The purpose of this paper has been to remind the American public and the American rubber chemists of the latent possibilities of this shrub. Surely American ingenuity is sufficient to conquer the perplexing problems of cultivation and propagation, and to build up within our borders, on land fit for little else, a truly American industry that will be a source of wealth in time of peace and a protection in time of war.

An Analysis of Tank Resistance in Electrolytic Refining

By Lawrence Addicks

The cost of power is always a considerable and usually a major item in any metallurgical process based upon electrolysis. In the ideal refining cell the energy consumption would be zero and the quantity of metal recovered per kw.-hr. therefore infinite, as the energy liberated at the anode would just offset that required at the cathode. In practice there are a host of resistances and counter electro-motive forces to be overcome, and a detailed study is necessary in order to understand the possibilities of improvement in any given case. In this article practice in copper refining by the multiple process will be inquired into as an example.

The pounds of copper recovered per kw.hr. expended at the switchboard depends upon the current efficiency, the current density and the items, both real and apparent, which make up tank resistance. The last is the subject of our present inquiry.
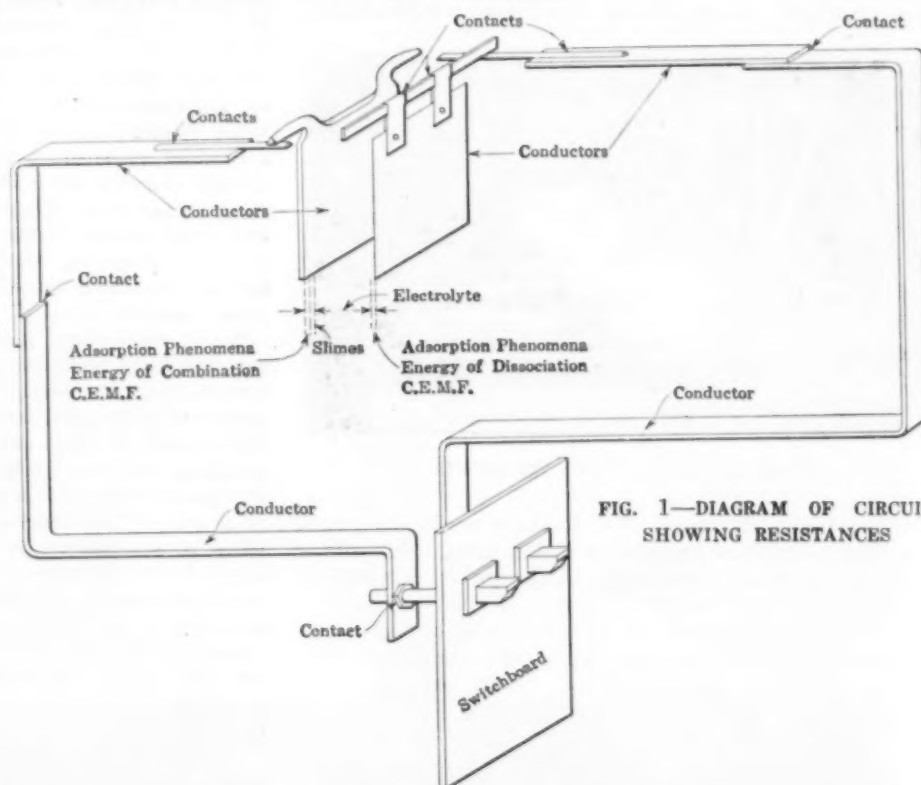
FIG. 1—DIAGRAM OF CIRCUIT SHOWING RESISTANCES

If we follow the course of the current from the positive pole at the switchboard, through the tank house and back to the negative pole, we shall find the series of obstacles to its passage shown in Table I, taking but a

TABLE I—CLASSIFICATION OF TANK RESISTANCE.

Item	Class	Nature
Busbar joints	Contact	Ohmic
Busbars	Conductor	Ohmic
Anode contact	Contact	Ohmic
Anode lug	Conductor	Ohmic
Anode	Conductor	Ohmic
Surface phenomena	Transfer	Ohmic
Solution of anode	Electrochemical	E. M. F.
Slimes	Resistor	Ohmic
Electrolyte	Conductor	Ohmic
Deposition of cathode	Electrochemical	E. M. F.
Surface phenomena	Transfer	Ohmic
Cathode	Conductor	Ohmic
Cathode loops	Conductor	Ohmic
Loop contacts	Contact	Ohmic
Rod	Conductor	Ohmic
Rod contact	Contact	Ohmic
Busbars	Conductor	Ohmic
Busbar joints	Contact	Ohmic

single tank in circuit for an example. This is also shown diagrammatically in Fig. 1.

It is evident that in actual practice we have the items in the tank proper multiplied by the number of tanks in a circuit, or, which is the same thing, we may work out the resistance per tank, apportioning to each tank its share of the busbar resistance.

The fact that for a circuit of a single tank the busbar resistance would be inordinate, has led to putting a number of tanks in series and then to a study of the relative arrangement of groups of tanks. The placing of additional tanks in series merely distributes the voltage drop in the leads between the switchboard and the tank house.

It has been generally considered good practice to keep the line voltage down to 200 volts or less, which places an upper limit of about 600 tanks in series. Actually circuits seldom carry above 400 tanks, and this is sufficient to make the incoming leads amount to but 3 or 4 per cent of the total voltage drop.

Fig. 2 shows the evolution of tank connections. *A* is the arrangement used in the first small installations. *B* is a modification employed at the old Anaconda refinery, long since dismantled. Here the parallel conductors resulted in halving the contact resistance between conductor-bars and tanks without using any more copper, as each bar was made half-size (*C*).

Then *A* was expanded into twin tanks, as shown in *D*. This resulted in halving the conductor-bars required, saving copper investment as well as voltage drop. Further, as the connections between twin tanks placed individual anodes and cathodes in independent pairs, it was claimed that a short circuit between electrodes in one tank was limited in its damage to efficiency by the resistance in series in the adjoining tank.

The old Anaconda tank *C* partly met this argument in that it was very wide, and two anodes were hung side by side from a single cross-bar. This required hanging the anodes by hooks, however, and this in turn increased the number of contacts.

Then came the Walker system, shown at *E*, where the idea of *B* was expanded indefinitely, it being found feasible to sacrifice accessibility, which was still preserved on one side of each tank at *D*, to power and investment saving. This resulted in a great saving in conductor-bars, and has been generally adopted. The connecting strips shown at *B* were dropped and a small triangular bar running the length of the tank partition

substituted without appreciable loss in efficiency. These bars are very small in cross-section, as they carry but half the current flowing through a single electrode when a tank is in normal condition.

Finally we have at *F* a further extension of the group idea, which has been proposed by several, in which the individual tanks are merged into one great basin, the Walker formation of electrode connections being virtually maintained, the tank partitions and triangular bars being replaced by a suitable iron beam to carry the load of the electrodes. This plan has received but a limited application, as it introduces in a modified form some of the disadvantages of the series system due to higher voltages without compensating gains. It would greatly decrease the first cost of a tank house, however, as well as that of tank repairs.

An idea of the magnitude of the different items constituting tank resistance may be obtained from Table II, which gives the results of an analysis I made a good many years ago of a tank house built on system *D*. It must be understood that the ohmic value given for counter electromotive force is simply the apparent equivalent

TABLE II—ANALYSIS OF TANK RESISTANCE

	Item	Ohms per Tank	Per Cent of Total
A.	Electrolyte	0.0000444	55.1
B.	Metallic conductors	0.0000131	16.2
C.	Contacts	0.0000113	14.0
D.	Counter electromotive force	0.0000040	5.0
E.	Slimes, etc., by difference	0.0000078	9.7
	Total	0.0000806	100.0
A.	Electrolyte	0.0000444	55.1
B. a.	Leads	0.0000024	3.0
b.	Conductor bars	0.0000085	10.5
c.	Anodes	0.0000002	0.25
d.	Cathode rods	0.0000010	1.2
e.	Cathodes	0.0000008	1.0
f.	Connection strips	0.0000002	0.25
C. a.	Anode contact	0.0000026	3.2
b.	Cathode loop contact	0.0000043	5.3
c.	Cathode rod contact	0.0000044	5.5
D.	Counter electromotive force	0.0000040	5.0
E.	Slimes, etc., by difference	0.0000078	9.7
	Total	0.0000806	100.0

under the conditions of operation, and further that in order to reconcile this resistance exactly with volts divided by amperes the current efficiency corrected for chemical corrosion would have to be allowed for.

Following this introduction, and keeping in mind that it is possible to reduce any of these resistances to very low values by changes in either construction or methods of operation, we shall now discuss these possibilities item by item. We have in general (1) carrying the current to and from the electrodes, (2) from the electrodes to the electrolyte, and (3) across the electrolyte, and we shall regroup the items in Table I in this fashion in order to avoid repetition.

Conductors

These consist of the leads from the switchboard to the tanks, the connections between the leads and the electrodes and the electrodes themselves. As the resistance of a conductor varies directly as its length and in-
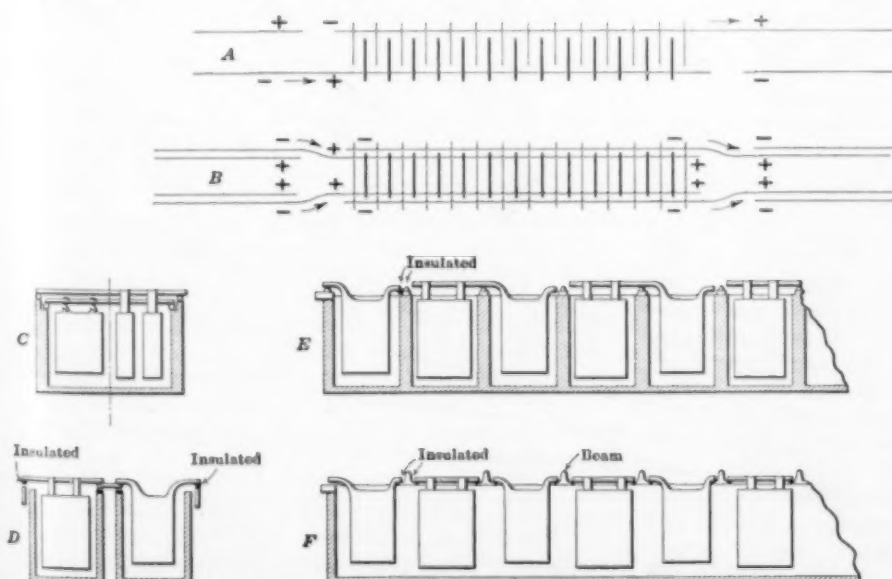
FIG. 2—VARIOUS TANK AND ELECTRODE ARRANGEMENTS

versely as its cross-section, while its first cost varies as the product of the two, we have from both points of view to make each connection as short as possible, while the cross-section involves a balance between first cost, the cost of power and sometimes strength. Carrying capacity does not enter as far as heating goes, as the other factors place this far on the safe side.

As we have a steady full load twenty-four hours a day, we can apply directly Thomson's law that the cheapest cross-section will be that for which the interest on the copper investment just equals the cost of the power lost by the voltage drop. The corresponding current density to be chosen for the conductors will vary greatly with the cost data for the individual case. This density is usually in the neighborhood of 500 amperes per sq. in., as against 1000 amperes commonly used in switchboard work.

Fig. 3 shows these relations graphically. A standard conductor 1000 ft. long and 1 sq. in. in cross-section, is taken, and two sets of curves superimposed, the first being the interest charges on the copper in dollars per year for different prices per pound for copper and various rates of interest, and the second being the power loss in dollars per year for different currents and various costs per kw.hr.

It is in this way possible to select the basic data and at once equate the two values.

For example, suppose we take copper at 15 cents a pound, interest at 10 per cent, and a kw.hr. at ½ cent, we enter the diagram at the bottom on the 15-cent line, and note that it intersects the 10 per cent line at $57 a year as our interest charge. This same $57 a year line, however, intersects the curve for ½ cent kw.hr. at an abscissa corresponding to 390 amperes, and as the conductor has 1 sq. in. area, this means a current density of 390 amp. per sq. in. An additional line on the diagram tells us that the voltage drop will be 3.4 volts per 1000 ft. of conductor. If we have 300 tanks on a circuit absorbing 0.32 volt each, and the generator is 500 ft. away, we should have a line voltage of 100 volts and 3.4 per cent loss in the leads, exclusive of any excess drop at joints in the bars.

The same principle applies to the various connections around the tanks, always remembering to figure out just what current each individual piece is carrying. Here, however, the element of strength enters in, and it may be necessary to make a cathode rod, for example, larger than is required for current carrying capacity, in order to obtain requisite stiffness. In some plants copper-covered iron is employed in such cases.

In the case of the electrodes themselves, the body of the cathode and anode are of ample cross-section. The cathode loops, however, are sometimes overlooked. Suppose we have a ca-

thode 3 ft. sq., operating at a current density (of electrolysis) of 20 amp. per sq. ft., hung by two loops, each 3 in. wide, cut from starting sheets 0.02 in. thick. We shall have a current of 3 x 3 x 2 x 20, or 360 amp. carried by a conductor 4 x 3 x 0.02, or 0.24 sq. in. in section, giving a density of 1500 amp. per sq. in., or far above the economical range.

The anode metal will be of low conductivity, but the lug through which the current enters is usually of ample size.

Contacts

It has been shown that the size of the metallic conductors is specifically determined by the cost of power and other considerations. In the case of contact resistances we have no desirable value, the proper course being to make them just as small as possible. Experiments show a contact resistance to be truly ohmic in character, the voltage across a given contact increasing directly as the current is increased. It appears to be due primarily to adsorbed air on the surfaces in contact, and secondarily to oxide or other foreign matter. Pressure and moisture lower the resistance.

We have two classes of contacts, one where permanent joints can be mechanically made, and the other where

FIG. 3—DATA FOR DETERMINING MOST ECONOMICAL SECTION OF COPPER CONDUCTORS

Power cost is for year of 8760 hours. One cubic inch of copper taken as 0.0000007 ohms, zero temp. coeff. and 0.32 lb.

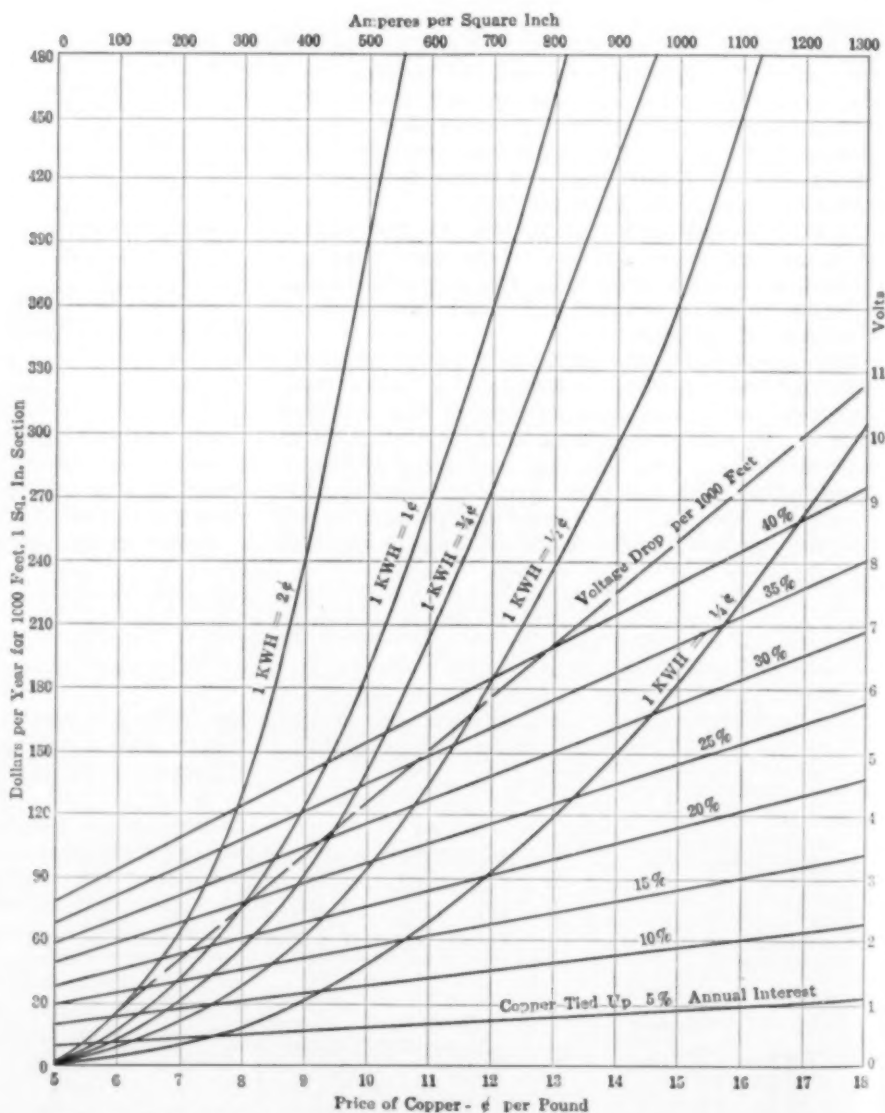temporary gravity joints must be used. It is customary on sliding joints, as in the case of switch surfaces, to keep the surface current density down to about 50 amp. per sq. in. In the case of busbars this figure can be greatly exceeded. A planed joint firmly bolted together will operate at 200 amp. per sq. in. without showing appreciable voltage drop—that is, 1 millivolt.

In the case of the loose gravity joints between the electrodes and their supports, we have one of the large sources of waste power in the system which can be attacked along three lines, namely, decreasing the number of contacts, increasing the acting pressure and improving the condition of the surfaces.

As the surest way of cutting down the resistance at a joint is to eliminate the joint, study has naturally been directed toward securing the minimum number of loose joints in series compatible with efficient handling of the electrodes. The various forms of anode and cathode suspension are shown in Fig. 4.

The anodes suspended by hooks have one single and two twin contacts equivalent to two series contacts; those

FIG. 4—VARIOUS FORMS OF ELECTRODES

with loops, one single and one twin, equivalent to one and a half; while the standard anode, with cast lugs, has but the single contact at the conductor or triangular bar.

The cathodes have gone through the evolution shown. The first example gives but a single contact, but has been abandoned on account of trouble with the rods in spite of painting at the solution line. The others give one and a half contacts, but a more reliable method of suspension. The part of the loop beneath the surface of the liquor does not matter, as this joint is soon covered by the deposited copper.

At one of the refineries work has been done on eliminating another contact by doing away with the triangular bars, allowing the cathode rod to rest directly on the lug of an anode in the adjoining tank. This is in effect returning to the connection shown at D in Fig. 2, but eliminating the connection strip.

The minimum number of loose contacts we can get along with is, therefore, one-half entering the anode, one-half at the cathode loops, and one-half leaving the cathode rod, or an equivalent of one and a half.

The pressure exerted upon the two surfaces has a great deal to do with the resistance shown to the passage of the current. For example, the contact resistance between the triangular bar and the anode increases day by

day as the anode dissolves away, and one of the loop contacts will show almost as high a resistance as the cathode bar contact, which has twice the current but twice the weight.

Various devices have, therefore, been tried to increase this pressure, notably plugs and clamps. At one plant holes were drilled in the anode lugs and these were reamed out to receive a tapered copper plug connected permanently by a short cable to the busbar. This is of no advantage if the original contact is kept clean, because we are dealing with such a low order of resistances that the short cable will have too high a resistance to be of much service as a parallel circuit. Of course, it does prevent excessive values for the joint, but with present-day methods of tank inspection these are not allowed to occur.

A number of years ago the writer tried out thoroughly the use of spring clips on the cathode loops and rod connections. These gave very encouraging results, cutting out over 80 per cent of the resistance. When the cost of renewing the clips from time to time, the labor of handling them and the additional hindrance in working around the tank was allowed for, some of this margin was eaten up. The great offset to such a plan, however, has been the improvement in keeping contacts clean, taken up below.

Much has been done in the lowering of contact resistance by shaping one of the members as a wedge which will bring a heavy unit pressure upon the other. This is the idea in the triangular bar, and it has been carried further in the proposition to have a wedge of a different angle from a corresponding groove which would result in crowding.

Finally we have the very important matter of the condition of the two surfaces. Contact resistances develop considerable heat, and this means that any drippings of electrolyte in the neighborhood of a contact will soon be converted into anhydrous copper sulphate forming a coating which effectually prevents a perfect contact.

The first principle is, therefore, to keep the contacts clean, and when set up the rods and under surface of the anode lugs are always brightened with sandpaper or its equivalent.

Various means have been tried for making a better union physically. Mercury cups are not practical for many reasons, but amalgamating the surfaces is possible. This gives excellent results, but the cost of the amalgam used, plus that of the labor applying it, amounts to more than the saving.

At one time a scheme was advanced for keeping the anode and cathode rod contacts wet by substituting shallow copper gutters for the triangular bars and allowing water to flow therein. This also gave good results, but at too great an expense for proper maintenance. Finally it was found that oiling a contact after shining it did not interfere with the contact itself, while it did serve to keep it clean for a long time, and cost almost nothing to apply.

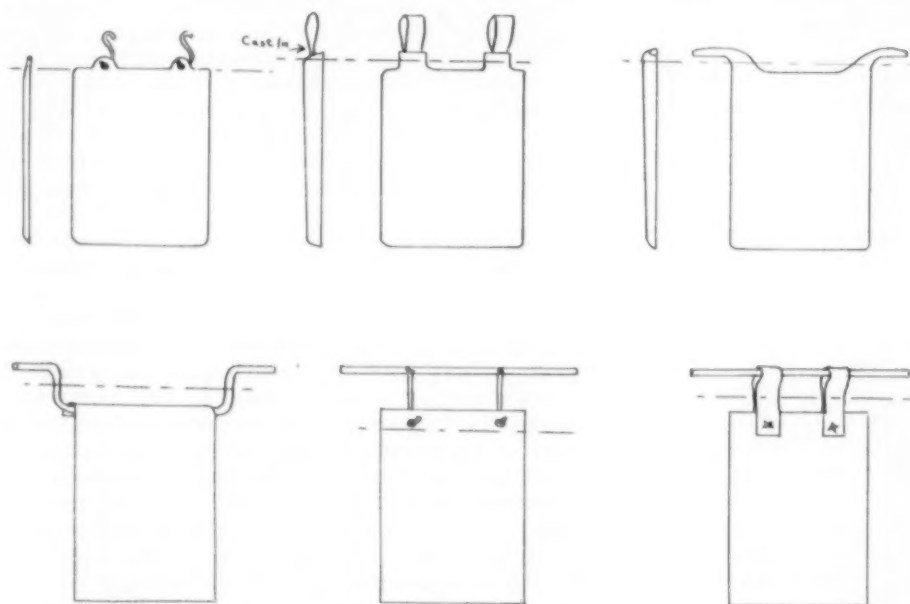The result of these various developments has been to

cut in half the values for contact resistance given in Table II.

It must not be thought that because the ohmic values are very small the financial equivalents are likewise so. Take the saving of one-half of 0.0000113 ohms per tank just spoken of, and assume power at ½ cent per kw.hr., 10,000 amp. on a circuit and 1500 tanks in the tank

house. The saving will be $\dfrac{0.0000113}{2} \times \dfrac{10,000 \times 10,000}{1000}$

$\times$ 1500 or 848 kw., equivalent to 848 $\times$ 24 $\times$ 0.005 or $102 a day.

Transfer Resistance

We come now to the transfer of the current between the electrodes and the electrolyte. This is a field which is very difficult to properly resolve into the several component factors. In true refining the total value is not very great, but bad conditions, such as poor circulation of the electrolyte, foul anodes, etc., may greatly increase the normal value. In general, we have to deal with counter electro-motive force, the ohmic resistance of an absorbed gas film and the screening effect of the slimes.

The counter electro-motive force is the opposing voltage due to the cell acting as a battery, and is due to the difference in composition between the anode and the cathode, and to the differences in concentration of the electrolyte around the two electrodes.

The first cause is small in its effect except in the insoluble anode tanks used for controlling the copper contents of the electrolyte which operate at about six times the voltage required for refining cells.

The second is due to the fact that the circulation of the electrolyte, which must be gentle in order to avoid stirring up the anode slimes and thereby contaminating the cathodes, is not sufficient to sweep away from the face of the anode the descending layer of solution rich in copper sulphate formed by the electrolysis, nor the corresponding lean layer which rises at the surface of the cathode.

This forms a Cu — CuSO₄ — Cu concentration cell with a small electromotive force tending to equalize the differences in concentration and therefore against the applied voltage.

It is quite easy to measure these two effects jointly by taking careful current-voltage readings while varying the current over a range not great enough to seriously change the conditions. If these readings are plotted and a straight line drawn through the points, this line will intersect the voltage base line at the value of the counter electromotive force on the circuit. In practice this amounts to from 0.01 to 0.02 volt per tank.

The ohmic resistance of what is doubtless an adsorbed gas film on each electrode is considerable and under some conditions may become enormous.

If we explore the potential gradient between anode and cathode we shall find a sudden drop as we leave the anode, a gradual slope across the electrolyte and another sudden drop as we reach the cathode. This film acts as a true ohmic resistance and has a temperature coefficient.

The various addition agents which have proved of such assistance in obtaining smooth deposits act markedly on this resistance. A moderate dose of gelatin in the electrolyte will increase the overall voltage required as much as 40 per cent.

Then we have the screening effect of a curtain of poorly conducting slimes on the face of the anode. A well-refined high-grade anode makes a loose granular slime which offers but little resistance to the passage of the current; less favorable conditions result in a thick greasy slime that is pierced in places by the current making for high resistance and irregular solution of the anode. The latter condition often results in what are sometimes called "crazy tanks" where a voltmeter across the tank will give no constant reading but jumps violently back and forth between a normal tank voltage and one about three times as great.

The value of the resistance due to adsorbed gas and sum of the values found for all other items and the total slimes can only be obtained by difference between the over-all voltage. This is generally about 10 per cent of the total resistance in circuit. This probably lies chiefly in the gas film and further study may discover some way of reducing this factor.

Electrolyte

We come finally to the resistance of the electrolyte itself and this brings up three questions, the necessary distance between anode and cathode, the composition of the electrolyte and its temperature. As the electrolyte comprises over half the total resistance in circuit, it is necessary that it be considered in detail.

The question of permissible electrode spacing belongs under the heading of current efficiency which we are not here discussing. It also depends upon the advisable age of electrodes, or particularly upon how many crops of cathodes correspond to a single set of anodes as each crop will operate on a wider spacing than the previous one. When three or more crops are drawn it may pay to respace the tank.

Spacing also is related indirectly to current density as additional density greatly increases the difficulty of working at close spacing. The foulness of the anode also has a bearing as voluminous or flocculent slimes demand greater distance in the interest of a clean cathode.

The average thickness of liquid column has been gradually reduced from 2 in. to about an inch and a half, due largely to better control of the physical character of deposits in late years. During the same period current densities have increased and the area of electrodes has been enlarged so that the full value of the improvement in deposit has been apportioned in several directions.

The composition of the electrolyte is very important. It may be considered to be made up of sulphuric acid, cupric sulphate, impurities in the form of sulphates or more complex compounds such as arseniates, etc., and finally addition agents.

The conductivity depends chiefly upon the mobile hydrogen ions from the dissociation of the sulphuric acid and, as would be expected, increasing the free acid within certain limits markedly lowers the resistance of the electrolyte.

There are limitations imposed by two difficulties. As we have a solution of mixed sulphates we are bound by the habits of isohydric solutions, the amount of dissociated hydrogen depending upon the relative concentration of the other sulphates as well as upon that of the sulphuric acid.

The other limit is due to the fact that too great a hydrogen concentration affects unfavorably the electrode surface phenomena discussed under a previous heading. The net result of these two limitations is that very high percentages of free acid do not give improved over-all results and it is not customary to carry above 13 per cent.

These same arguments require carrying as small an amount of copper sulphate in solution as shall give a satisfactory deposit at the cathode. This is borne out in practice although the variation in conductivity is not very great with changes in the copper concentration. A complete set of measurements of the conductivity of different mixtures of copper sulphate and sulphuric acid is

reported by Richardson and Taylor in Vol. XX of the Transactions of the American Electrochemical Society.

With good operating conditions the copper in the electrolyte can be carried down below 2 per cent without impairing the cathode deposit; were it possible to increase the circulation, even lower values could be considered. It is unwise to proceed too far in this direction, however, and values between 2.5 and 3.0 per cent are considered good practice. Even under difficult operating conditions there is no particular advantage in carrying over 3 per cent copper. The early electrolytes were carried at 4 per cent copper and 8 per cent free acid; these have gradually been modified to 2.75 per cent copper and 12 per cent free acid.

The specific resistance of such an electrolyte at 120 deg. Fahr. will be about 0.7 ohm per cubic inch. The various impurities in the electrolyte will increase this anywhere from 5 to 15 per cent so that a working value will be about 0.8 ohm. A reasonably accurate measurement of this resistance may be obtained with an ordinary voltmeter and two copper electrodes if the column of electrolyte measured be long enough to render negligible the voltage effects at the electrodes. Whether this length has been obtained may be tested by increasing it and seeing if any lower readings per unit of length are obtained. Eighteen inches between electrodes will generally be found sufficient.

The minute quantities of organic addition agents have probably but slight effect upon the conductivity of the electrolyte, their effect upon the resistance being at the electrodes. On the other hand, inorganic agents such as ammonium sulphate, used to be added in large quantities and these had, of course, to be reckoned with, any increase in sulphates tending to drive back the dissociation of hydrogen ions.

The temperature of the electrolyte is a very important matter. In the first place the electrolyte itself has a positive temperature coefficient of about 0.5 per cent per degree Fahr. There is not only this enormous premium set upon running with the solution hot, but in addition the electrode conditions are greatly benefitted. The disadvantages are the cost of heating, the increased humidity of the atmosphere in the tank house and the increased growth of copper in the electrolyte by chemical action.

It is customary to heat the liquors to about 135 deg. Fahr. in the circulation wells and this temperature drops 20 deg. or so in passing through the system, resulting in different resistances in different tanks.

Some of the older plants had long cascades of tanks, the electrolyte flowing through five or six tanks in series; modern plants have generally but two tanks in series so that the temperature inequalities are not so severe as formerly.

We have now discussed item by item the various components of tank resistance. In making these up into a sum to compare with the readings of the switchboard instruments we must see to it that we have properly allowed for the number of series-parallel circuits formed by the multitude of anode-cathode pairs, for the proportion of tanks which are "locked out" so many hours a day for replacement of electrodes and cleaning of slimes, for the special conditions in insoluble anode tanks and finally for the negative factor introduced by imperfect current efficiency which provides a by-pass or parallel circuit for a certain part of the current, the discussion of which will be taken up in a later article.

Franklin Institute.—A lecture will be delivered on Dec. 14, 1916, at the Franklin Institute, Philadelphia, Pa., by Prof. C. C. Thomas of Johns Hopkins University, on "The Cooling of Water for Power-Plant Purpose."

New Courses in Industrial Chemistry in England

The Bradford Technical College, Bradford, England, realizing that the war has given impetus to various chemical industries, has prepared, according to Commerce Reports, a comprehensive scheme to afford training to students preparing to enter the chemical industries, especially the dye and textile industries. A pamphlet issued by the Bradford education committee gives particulars as to the courses, and states that there is likely to be an increasing field in analytical work for women. Usually, for appointment to a position as an industrial chemist a degree in chemistry from some university, a day diploma of one of the higher technical colleges or the associateship of the Institute of Chemistry is required.

The subjects for the diploma in chemistry and dyeing are:

Inorganic chemistry, physical chemistry, organic chemistry, chemistry of dyestuffs, principles of analysis, technical analysis, chemical calculations, glass working, analysis of dyes and fibers, color matching, dyeing and finishing, structure of yarns and fabrics, mechanics as applied to chemical industries, mechanical drawing, mathematics, physics, practical physics, descriptive electrical engineering, practical chemistry, experimental dyeing, practical dyehouse work, etc.

A similar course has been arranged for those who intend to take up work in other chemical industries apart from the textile side, such as oil and soap works, metallurgical, gas engineering, etc.

The college possesses a practical dyehouse, with full-sized machinery, providing opportunities for large-scale dyeing, and combined with this is a finishing plant for completing the commercial treatment given to cloth. In addition to facilities for special experimental and research work, visits to chemical works, gas works, sewage works, tar works, soap works, and dyehouses are arranged, so that students have an opportunity to see processes which have been described in lectures carried out on a manufacturing scale. There are also special courses in pharmaceutical chemistry, a branch of work which is now offering a continually increasing scope for women.

Proper Current Densities

By B. B. Hood

Assistant to the Superintendent, U. S. Metals Refining Company Chrome, N. J.

When it is necessary to install large amounts of copper to transmit electric power the question of interest on that copper should be taken into consideration when figuring the size of conductors. The cost of operating such transmission lines may be taken as the interest on the copper tied up plus a certain per cent for amortization plus the cost of the power lost. For direct-current work this will be a minimum when the cost of interest, etc., equals the cost of power lost, since interest varies directly as the copper involved, while the power lost varies inversely. Having a certain amount of power to transmit, in order to figure the size of conductors, the proper current density should be determined. Into this problem will enter the resistivity or conductivity of the copper to be used, the temperature at which it is to be operated, the cost of the copper installed, the rate of interest on the investment and amortization, and the cost of power to be transmitted.

From the chart Fig. 1 the proper current density in amperes per square inch may be determined, and from it the size of conductors readily figured. Taking the example given find the point where the 93 per cent line

CHART I—PROPER CURRENT DENSITY FOR COPPER TRANSMISSION LINES

Example:—Copper bus bar having a conductivity of 93%
(Matthiessen's Standard) to be operated at an average temperature
of 38° C. Cost of copper = 30c. per lb. Interest + amortization of
investment = 14%. Cost of current = $40.00 per kw.-year. Proper
current density = 655 amp. per sq. in.
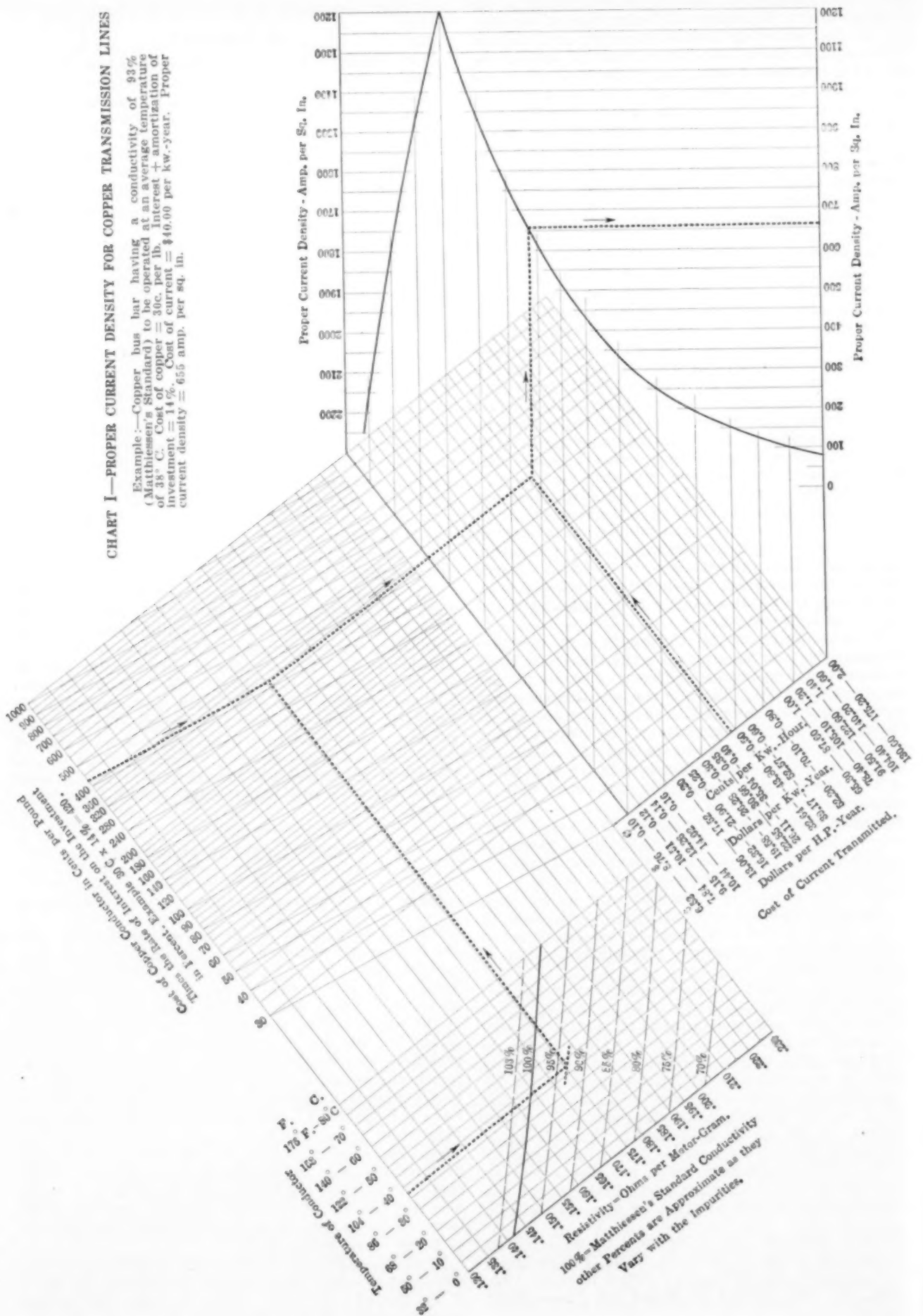
Chart II Copper vs Steel Conductors
of the same Cross Section Area
Showing the relations between, Cost of Copper,
Cost of Steel, Rate of Interest and Amortization,
Cost of Power Transmitted, and Current Density,
when Copper Conductors = Steel Conductors in
Cost of Operation.

Cost of Operation being equal to
Interest on and Amortization of the
Investment, Plus the Value of the
Power Lost. Knowing Four of the
Five Factors the other one can be
determined from the Chart.

Example
Current Density = 248,   Interest etc.= 12.5%
Cost of Power = 0.33¢/kwh. Cost of Copper = 24.5¢
Ans.   Cost of Steel = 6.5¢ per Lb. If Steel Costs
less than 6.5¢ it would be cheaper than Copper
in Cost of Interest etc. + Current Lost.

This Chart is based on a Copper
Resistivity of 0.155 Ohms per Meter Gram,
which is Equivalent to Approximately 99%.
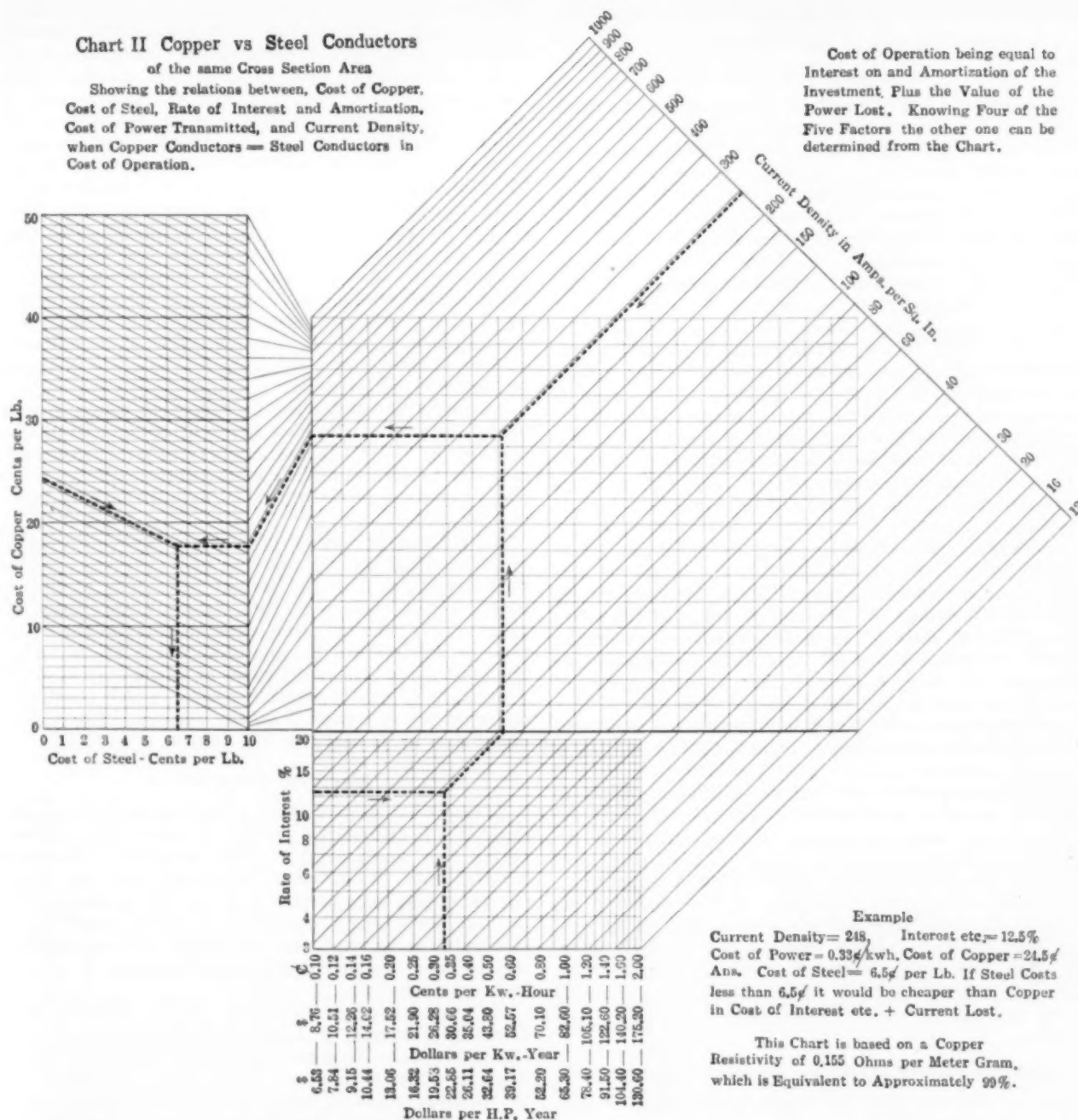
crosses the 38° C. line. Multiply the interest of 14 per
cent by the cost of copper, 30 cents, getting a factor of
420. From these points follow the dotted lines until the
line representing the cost of power at $40.00 per k.w.
year is reached, from thence over to the curve and
down to the proper current density 655 amperes per
sq. inch.

Suppose we consider an electrolytic refining plant
using copper conductors under the above conditions. If
instead of using the proper current density, 150,000 lbs.
of conductors were installed, using a density of 900 am-
peres, what would be the yearly loss?

The interest charge on the investment would be $6,300
per year. If the density of 655 amp. were used, the
power loss would amount to $6,300 per year. With 900
amp. the power loss will be $\left(\dfrac{900}{655}\right)^2 \times 6300 = \$11,890$, or
a total of $18,190 per year for operating. This makes
no allowance for the increased temperature of the con-
ductors above 38 deg. C., which would take place and
increase the loss. If the installation were made so that

655 amp. per square inch was obtained, there would be
$\dfrac{900}{655} \times 150,000 = 206,200$ lb. of copper conductors in-
stalled which would have an interest and power cost of
$8,660 per year each, or a total of $17,320. This would
make a saving of $18,190 — $17,320 = $870 per year
over and above all allowances for amortization, etc.

Some times a conductor must be large enough to sup-
port a weight such as a cathode. In that case it may
be possible to substitute steel with a saving, providing,
of course, there are no other conditions which do not
prohibit the use of steel. From the chart in Fig. 2 it is
possible to determine whether steel will compete with
copper in cost of operating. If in the example given
steel costs less than 6½c. per lb. installed it would be
cheaper to use than copper. This situation exists large-
ly because a lower current density is used than would
be proper if the conditions, upon which the chart in
Fig. 1 is figured, were all that were considered, instead
of bringing in the question of strength.

Chrome, N. J.

Some Recent Developments in Scientific Instruments and Materials*

By Edward Schramm

In considering the relation of the Bureau of Standards to things "made in America" we must make clear at the outset that its primary contribution lies not so much in the development of special products as in the acquisition of knowledge through tests and investigations, and the spread of information by means of publications and a large correspondence. To cover the broad field of the bureau's work lies quite without the scope of this review, and a few examples must suffice to indicate the nature of its activities.

Within the past few years the testing and certification of radium products has been undertaken; this work has enabled the purchaser to discover exactly what he was getting and has thus removed the element of uncertainty and danger of fraud from the industry.

The preparation and sending out of standard samples of materials of certified composition or properties by means of which laboratories may easily check their methods of analysis or testing is an important part of the bureau's work.

The bureau is co-operating with technical and scientific societies and manufacturers in the attack on certain important problems of industrial interest, among them the following: A comparative study of the effect on quality of rails of several methods of producing ingots; an investigation of the factors influencing the operation of electrotyping baths; investigations of methods of minimizing the destructive action of stray electric currents on underground structures; investigations of the fire resisting properties of structural materials, in co-operation with the Fire Underwriters and Mutual Laboratories and various engineering and industrial societies and associations; investigations relating to the elastic properties of steel columns in co-operation with the American Society of Civil Engineers and the American Railway Engineering Association.

Leaving these broader aspects of the work of the bureau, the remainder of this review will be devoted to a field in which it has a special and immediate interest, that of instruments and materials for scientific uses. In what follows, a necessarily brief account is given of some of the bureau's experiences with such products.

Measures of Mass, Length and Volume

Let us consider first the fundamental measurements of mass and length.

Balances and weights of the same grades as those obtained in Europe have been made in this country for many years. Many foreign balances have been imported in the past because of their lower prices, and some because of the reputation of the makers, but only a few special types could not be obtained in this country. The war has made no apparent changes except greatly increased production.

With regard to volumetric glassware the situation appears to be that American makers can make fine apparatus if they will, but that they find greater profit in the bulk production of common articles, a statement which applies to many other lines.

For tapes and other measures of length there is a tendency to replace ordinary steel by iron-nickel alloys. The dimensions of the alloy containing 36 per cent nickel along with small amounts of manganese, silicon,

and chromium, in all about 1 per cent, were found by Guillaume to remain almost invariable with ordinary atmospheric changes of temperatures. For this reason it was called "Invar," and has been manufactured under that name in France. The Bureau of Standards is conducting an investigation in co-operation with a steel company for the purpose of producing American steels of specified thermal expansivity, combined with stability of dimensions and other desirable properties.

At present steels of small expansivity are being studied to determine the effect of various thermal, magnetic, and mechanical treatments as well as of slight variations in the constituents. This has already resulted in the production of specimens which, as far as small expansivity is concerned, compare favorably with good French "Invar"; but as yet sufficient time has not elapsed to show how stable they can be made in regard to constancy of length.

An important material, the supply of which was cut off by the war, is the finer grade of sieve cloth used in the testing of cement and similar products. American manufacturers are making every effort to duplicate this cloth, but some of their product appears lacking in the desired uniformity.

An alternative method of cement analysis depending on blowing out the fine particles by a current of air has been investigated in the cement laboratory of the bureau. While requiring more elaborate apparatus and greater time than the sieve separation, it has the advantage of subdividing the material which would pass a 200-mesh sieve into four grades of fineness, thus giving a measure of the impalpable powder which constitutes the true active material of the cement. The method ought also to be useful in the testing of abrasives.

Electrical Instruments

America has always taken a leading place in the production of commercial electrical measuring devices, only a very small quantity being imported. Watt-hour meters, both the alternating-current and the direct-current types, were originally developed in this country, and are now being produced in enormous quantities by elaborate factory methods. Together with ampere-hour meters they are now being exported, even to Europe, in large quantities.

As in many other industries, one of the most characteristic features of American manufacture is quantity production. In many cases our manufacturers have made no effort to develop special forms of apparatus of the highest grade in which great refinement is necessary, and for which there is only a very small demand from universities and research institutions. Much of such apparatus has been imported from Europe, where small but successful businesses have been built on just such work. Of course, the highly skilled labor available abroad at relatively low wages has been an important consideration in this.

The alloy manganin which is of fundamental importance in most precision apparatus used in electrical measurements was developed in America, but has heretofore been imported from abroad. It is to be hoped that American makers will market this alloy as well as others of similar characteristics in sufficiently good and uniform quality to meet the requirements of the manufacturers of precision apparatus. There is also an unfilled need for certain highly specialized materials used in instrument manufacture, such as very fine wires and small circular levels.

In comparing American and foreign-made instruments, it may be noted that the preferences of the user, which may be very different in different countries, have had an important influence on design. Americans often

prefer to sacrifice somewhat in accuracy to obtain convenience and compactness. For example, certain foreign portable photometers are capable of greater accuracy than are American instruments, but the latter are much more compact and convenient to use, and their accuracy is sufficient to make them really more efficient in the work for which they are intended than are the foreign instruments.

It is interesting to note that two American manufacturers are producing galvanometers which are decidedly superior to any made abroad. The very highest grades of ammeters, voltmeters and wattmeters are available in American types. Very inexpensive direct-current instruments are now made in large quantities, particularly for automobile service. American manufacturers have not, however, produced alternating-current instruments in such inexpensive models as have the German and French makers. Hot wire instruments for radio work were formerly imported, but are now largely supplied by American makers.

Thermometers and Pyrometers

Nearly every type of thermometer used for laboratory or industrial purposes is now made by American manufacturers, such as clinical, calorimetric, Beckmann low-temperature, high-temperature (540 deg. C.), and various types of industrial thermometers. Practically the only exceptions are thermometers of special types, of very limited use, such as deep-sea thermometers, liquid pentane-in-glass thermometers for use down to very low temperature (—400 deg. Fahr.), and primary standard thermometers.

Industrial thermometers, sometimes called mechanical thermometers, are mecurial thermometers provided with special mountings to adapt them to special applications in the industries, e.g., for galvanizing baths, annealing ovens, distillation apparatus, etc. In this field of thermometry, American manufacturers have taken the foremost position and are exporting their product even to the European countries.

It was formerly necessary to import thermometric glasses; an American firm has now placed on the market special thermometric glasses that are in every respect as satisfactory as the well-known Jena normal and borosilicate glasses. Quite recently this firm has developed and placed on the market a new glass having a very low coefficient of expansion, which adapts it to a wide variety of heating requirements.

In the development of pyrometers, a very marked progress has been made in late years. Until quite recently we were almost entirely dependent on the product of European instrument makers for all high-temperature instruments. To-day, practically all types of pyrometers, thermoelectric, electrical resistance, optical and radiation are being produced by American firms. New instruments, now in development, which will mark a noticeable advance will soon be placed on the market. Several new and very active firms have been experimenting in the past three years, and others have enlarged their scope and models.

We are still dependent, to some extent at least, on the products of European platinum refiners, for the platinum and the platinum-rhodium wires used in thermoelectric pyrometers. It is much to be hoped that some of our platinum refiners will place on the market thermocouples which, although purchased at widely different times, will yet be reproducible in their temperature scales to within 5 deg. to 10 deg. C.

Along with the developments in thermometry and pyrometry, there has been notable progress in the development of other instruments required in heat and temperature work, such as special resistance bridges and resistance thermometers used in calorimetric work, recording instruments for use with thermoelectric and resistance thermometers, instruments for detecting and for recording the critical points of steels, electric furnaces and ovens, bomb and other special types of calorimeters, gas calorimeters of the flow type, etc. All of these instruments have successfully met the most exacting requirements of the laboratory and of the works.

In the recent developments, which have been briefly referred to above, the bureau has often worked in close co-operation with the manufacturer, and has thus often been able to render valuable assistance and also has been in a position to control, in a measure, the accuracy of these products.

Optical Glass and Optical Instruments

The chief factor in the manufacture of fine optical instruments is the production of suitable glass for lenses and prisms.

A well-known European maker through long years of experience and thorough investigation has developed glasses adapted to various special needs. It is hardly to be expected that such results can be duplicated in a day, any more than a dyestuff industry can be improvised, but it is gratifying to note that four or five American firms are attacking the problem of optical glass manufacture with marked success.

The Bureau of Standards is also taking up the question in its broader aspects and hopes to be able to contribute to our growing independence of the foreign supply.

There are few optical instruments not being made here to-day. We are making our own microscopes, spectroscopes, engineering instruments and binoculars, and are even exporting some of these articles. Perhaps the greatest need of this industry is the development of a body of highly skilled workmen.

Metals

America's rich endowment of minerals and her advanced position in the metallurgical art are matters of common knowledge. It would be impossible here to attempt to record the progress in this great industry, but it will not be out of place to mention several developments that may properly be considered within the scope of this review, for metals frequently form both the tool of the scientist and the subject matter of his investigations.

Platinum is one of the most indispensable laboratory materials, and American producers are making every effort to increase the supply. Notable quantities are being obtained from the copper refineries.

For the purpose of determining and thus indirectly maintaining the quality of platinum ware, a method of testing devised at the Bureau of Standards has proved of great value. The method consists briefly in determining the thermoelectric force of the article to be tested against known pure platinum and then reading from a curve the corresponding rhodium or iridium content. In this way it is possible to determine with accuracy the total amount of impurity and to predict the loss in weight on heating without in any way injuring the article.

As material for investigations the Bureau of Standards is at the present time greatly interested in the pure metals. Through the development and extension of electrolytic refining methods, American companies are now producing in considerable bulk the purest copper, aluminium, zinc, tin, lead, nickel, and cobalt. By melting point and other physical tests these metals have proved equal in quality for scientific work to the small samples formerly imported.

In the case of the commonest metal, iron, it was

found impossible to procure on the market a product of sufficient purity to form the basis of a projected study of this metal and its important alloys. The preparation was accordingly undertaken at the bureau. A metal containing only three or four-hundredths per cent of impurities has been obtained in a form suitable for the determination of various physical constants.

Chemical Glassware

Since it appeared that this country would soon be thrown entirely on its own resources for chemical glassware, a series of comparative tests of two foreign and three domestic makes has been carried out at the bureau.

As the details of these tests, now in progress, are to be published later, it will suffice here to present the results in the form of curves (Fig. 1) and to call attention to the excellent manner in which the American wares (2, 3, and 5) compare with the foreign products (1 and 4) as regards resistance to attack by various reagents.

On treatment with water, with potassium carbonate, and with sodium carbonate, foreign glass No. 1 proved markedly inferior to the other four.

On boiling with caustic alkalies the differences in behavior of the five makes are not significant, while on evaporating with such solutions all the glasses suffer such great losses that this treatment must be considered inadmissible.

With ammonia, ammonium sulphide and ammonium chloride, and a mixture of strong acids, all the makes behaved excellently, No. 1 showing a somewhat greater loss than the others with ammoniacal solutions. It may be concluded in general from the data obtained that the problem of making chemical glassware in America has been satisfactorily solved.

Ceramic Products

KAOLIN PURIFICATION

In work done at the Bureau of Standards and elsewhere it has been shown that clays respond to colloidal reactions, and that caustic soda affords the best means of deflocculating most clays, that is, bringing about a greater dispersion by breaking up the larger particles into finer ones. In this manner the coarser, granular impurities of clay can be readily separated from the fine-grained clay substance proper, since the latter is kept in suspension.

The principles underlying the refining of kaolins and other clays, as well as the effect of alkalies in the so-called casting process have been brought out in two contributions of the bureau.

The process outlined has been installed in a plant in eastern Pennsylvania under the direction of the Ceramic Section and with excellent results.

PORCELAINS

A comprehensive study has been made of the various types of porcelain, both from the theoretical and the practical standpoint. It has been found possible to
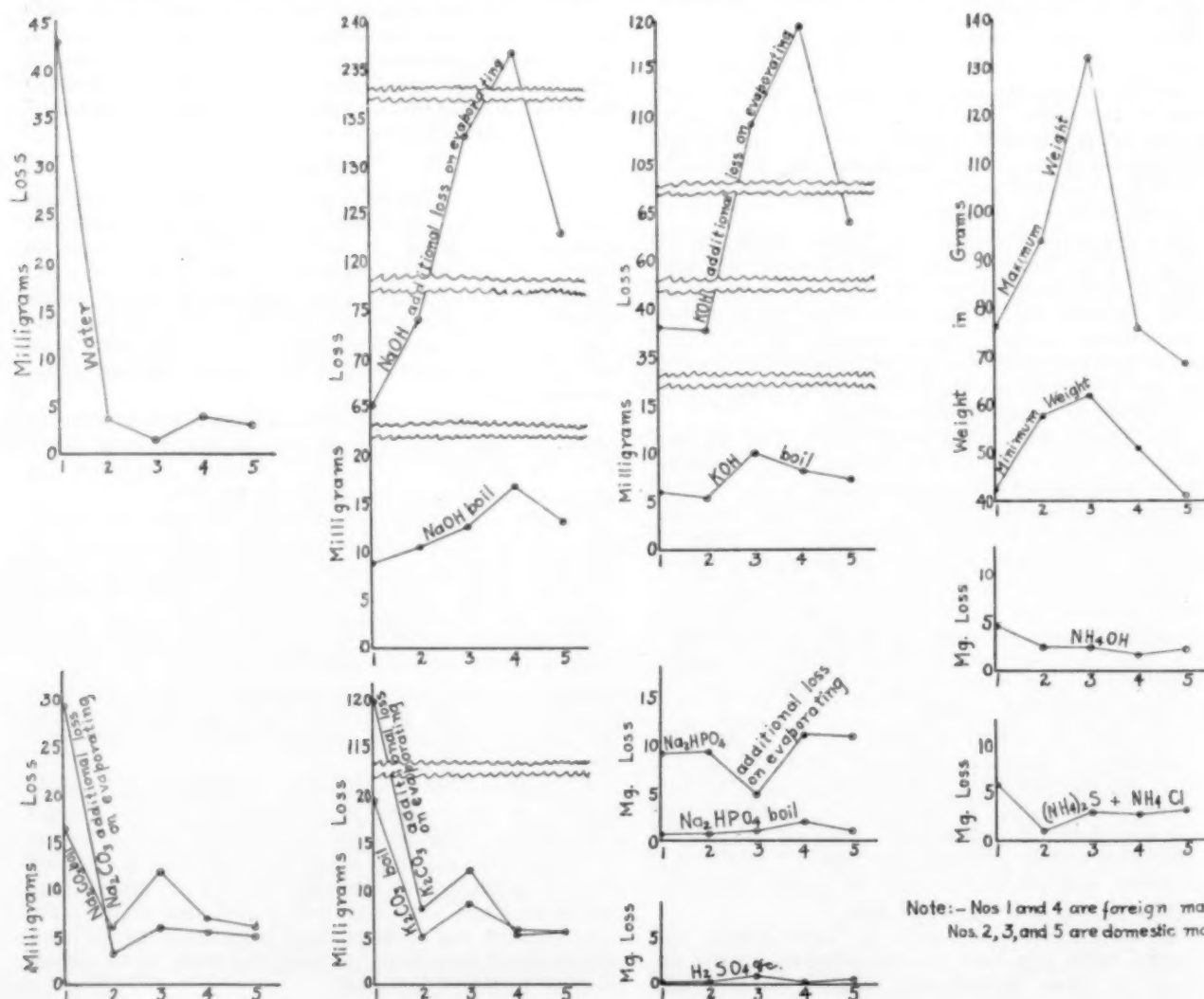

FIG. 1—LOSS IN WEIGHT OF BEAKERS ON TREATING WITH VARIOUS REAGENTS

show clearly by means of petrographic examination what takes place in the vitrification of a porcelain and to differentiate between the several types of domestic and foreign porcelain. The temperature requirements in burning have likewise been established.

Simultaneously a number of hard porcelain compositions have been worked out which have been freely imparted to manufacturers interested in this work.

Owing to the impossibility of securing the refractory Marquardt porcelain, used for pyrometer tubes, etc., work was done in this connection. A very satisfactory body and glaze have been developed, the compositions of which have been made public. At the same time the ceramic section has co-operated with one firm and assisted in the installation of a plant for the manufacture of this type of porcelain.

PLASTIC BOND CLAYS

The failure of the supply of the European plastic bond clays used in the manufacture of glass pots, graphite crucibles, etc., has made it desirable to establish clearly the physical properties of the imported materials in order to make possible a comparison with domestic clays which are available. For this reason, five clays—four German and one French—were examined and tested.

From the results obtained, tentative specifications governing this type of clays have been suggested. It has been found that there is no reason why domestic clays should not be used to replace the foreign materials, but the fact is emphasized that not single clays, but mixtures of two or three domestic materials, should be employed.

By proceeding in this manner, satisfactory industrial results should be obtained, superior in fact to those with the use of the imported clays, since the latter possess certain defects which can be overcome. At the present time at least six American deposits of excellent bond clays are available. Considerable co-operative work has been done by the bureau with manufacturers interested in the use of these materials.

GENERAL REFRACTORIES

Considerable work is being done by the clay products section in assisting in the working out of methods of testing and specifications for the different classes of refractories. It co-operates rather extensively with such associations as the American Gas Institute, the American Society for Testing Materials, and the Refractories Manufacturers' Association.

The results obtained in connection with the work on the ability of clay refractories to resist load conditions at furnace temperatures have been generally confirmed.

Some attention is paid also to the development of special refractories such as the spinels, zirconia, and other substances. An elaborate study of silica refractories is under way.

Use of the Metric System

It would not be fitting to close this survey without some reference to an important step of progress brought about by the war. The growth of our trade with Latin America is forcing many manufacturers to adopt the metric system for their export business, and they are learning to think of grams and millimeters without an attack of mental prostration. The situation is well covered in Senate Document No. 241, 64th Congress, 1st Session, a report on the "Metric System in Export Trade," by the Director of the Bureau of Standards. The modes of use of that system are grouped as follows:

(a) Complete use of metric system in designing, making and selling.

(b) Price listing in metric equivalents (to enable the foreign buyer to understand quantities and prices).

(c) Packing products in units of metric size.

(d) Labeling metric equivalents on the unit packages the contents of which may be put up in customary units.

(e) Stenciling shipping cases for export with the quantities in metric units to meet the customs requirements in metric countries.

(f) Filling metric orders with the regular sized packages or products, merely billing in metric terms to enable the buyer to check price.

It is now possible to get all sorts of rules and gages, taps, drills, and other tools in metric as well as ordinary units. Perhaps the greatest benefit of the adoption of the metric system in export trade will be the reflex effect on the domestic market. Many metric products have been found available for home use, and we may look forward hopefully to the day when we shall have advanced as far as China in the adoption of a scientific system of weights and measures.

In conclusion, the author wishes to call attention to the fact that this paper is essentially a compilation and to express his thanks to the many members of the bureau staff who have contributed the information on which it is based. He is especially indebted to Mr. P. H. Walker for the data on chemical glassware, and to Messrs. P. G. Agnew, C. W. Waidner, and A. V. Bleininger, who have written the sections on electrical instruments, thermometers and pyrometers, and ceramics, respectively.

Silico-Manganese.—The electric furnace of the Noble Electric Steel Company at Heroult on the Pitt, Shasta County, Cal., which has been in continuous operation since April 15 making ferromanganese and at times pig iron, is now producing silico-manganese, containing 50 per cent manganese and 30 per cent silicon.

New Steel Works for Norway.—Norway is increasing its iron industry by two new iron works, which will make ship plate and other shipbuilding materials The larger of the two, the A/S Norskevalserverker, will be located near Christiansand and is capitalized at 5 to 10 million dollars. The initial output of the plant will be 80,000 tons of finished product. The second plant, which as yet is unnamed, will be capitalized at $2,140,000 and have an annual output of 20,000 tons.

Enlargement of the South African Steel Works.—The small steel works at Vereeniging, Transvaal, South Africa, will be enlarged in the near future. The capacity of the present plant is 500 tons of steel a month, while the enlarged plant will produce 1000 tons in the same length of time. The materials used for the erection of the furnace will be supplied locally with few exceptions. The open-hearth furnace will be of the latest type and will have a chrome-ore hearth. (Commerce Reports, Oct. 13, 1916.)

Meetings of the Detroit Chemists.—The following meetings of The Detroit Chemists which is the Detroit section of the American Chemical Society, have been announced by the secretary, James H. Bogart:

Nov. 16, Dr. L. H. Baekeland, "Synthetic Resins."

Jan. 18, Dr. W. D. Richardson of Swift & Co., Chicago. Subject not yet announced.

Feb. 15, Mr. F. W. Steere of the Steere Engineering Co., "Producer Gas and Its Uses."

March 15, Dr. Louis Deer of M. I. T., "Color Photography."

April 19, Dr. C. E. K. Mees, "Photographic Research," an example of the work of a specialized research laboratory—to be illustrated.

The Brass Foundry*

By E. A. Barnes

In the brass foundry, as it existed thirty years ago, whether it was a separate institution doing a jobbing business, or an adjunct to a factory or rolling mill, the facilities which the moulders had at their disposal were far short of those available to-day. Considering the disadvantages under which the earlier brass foundries were operated, the workers in them should be given great credit for the work they were able to turn out.

Thirty years ago the brass foundries had but two choices of fuel, coke and hard coal; whereas to-day gas, coke, coal, fuel oil and electricity are available, and each, as you well know, has its own particular sphere of usefulness. The Fort Wayne Electric Works, I think, was one of the first electrical companies to adopt fuel oil in its foundry. We at first had to use the oil with much care, and it was necessary to do considerable research work in connection with the use of the oil, for the improved furnaces, burners and appliances available to-day were not then in existence.

A present-day brass foundry would certainly not be considered up-to-date unless it had compressed air for use in blowing off patterns, operating moulding machines, jarring machines and squeezers of various types. Even the individual work bench of the modern brass foundry is equipped with air nozzle and rapping hammer, enabling the workman to get along without assistance from his neighbor, except in special cases.

Modern foundries, too, make use of power-operated moulding machines of many various designs, which, compared to the crude hand-operated machines of earlier days, look as if they might be the last word in foundry advance, and yet we feel that we are only just starting to introduce modern labor-saving machines into the foundry.

The value to the brass foundry of an efficiency engineer and chemist is now unquestioned. Especially where the output of the foundry is quite large, the savings to be effected by having a chemist and engineer on the premises to run down troubles, develop special alloys and make suggestions for handling peculiar propositions are greatly in excess of the salary outlay.

With all our modern foundry equipment and the special services of engineer and chemist, the resourcefulness of the foundry is often taxed to the limit in solving some of the problems encountered. One proposition that was lately put up to our brass foundry was that of producing commercially large quantities of duplex thermostatic metal. It was necessary to cast or otherwise fuse together a brass alloy and a plate of nickel steel, the alloy to be of such a nature that it would stand rolling down to three-thousandths of an inch thick and even less, and the finished duplex sheet to be exactly 50 per cent brass and 50 per cent nickel steel. In order to secure the required results, it was necessary to have control of the casting of the yellow brass, which meant in the first place the necessity of pure copper. Curiously enough, we found only one particular brand of zinc that would give consistently satisfactory results in the alloy. Many experiments were tried, but either the brass cracked into small pieces or became detached from the steel plates; but by persevering in the experiments we finally developed an alloy which has the proper characteristics to stand the rolling and annealing process and remain firmly joined to the nickel steel. Our final result is a perfect metal for the purpose it is designed to fill.

A foundry problem which has many times puzzled us, and other foundries, too, no doubt, is when and where to commence making use of metal patterns for repeat work. Our experience has been that it is best to make a first-class wooden pattern and use it as long as possible. We find that our engineers and designers frequently wish to make certain structural changes in the part after the first castings have been put into use, and since a wooden pattern usually can be much more readily changed than could a metal one, we use the wooden pattern at the start. Any unprotected wooden pattern, however, soon wears and warps, due to the rough treatment the pattern naturally receives; we have, therefore, been on the lookout for some method of increasing the life of the wooden pattern. In this connection we have been experimenting with the "Schoop" metal coating process.* With the "Schoop" pistol, copper or lead coating, as desired, can be applied to fragile and even complicated wooden patterns. This metal coating is supposed to render the patterns waterproof and stiffen them up so that they will hold their shape and more successfully resist the wear and tear incident to the moulding process. At this time we have not done enough of this work to pronounce it an absolute success, but the wooden patterns which we have coated by this process, some with the lead and some with copper, have given surprisingly satisfactory results. We believe that it only requires a little more research work to prove this system highly satisfactory and the scheme to use where the cost of metal patterns is not merited, and yet, due to extensive use, the ordinary wooden patterns become expensive from the need of being frequently replaced by new ones.

Another difficult problem with which we have had to contend is the making of aluminium castings which would take a high polish. This problem developed in connection with the furnishing of parts for therapeutic instruments, such as vibrators, etc. We tried all the standard alloys, but the castings invariably were full of small black specks due to gas in the metal. We were absolutely unable to get a satisfactory casting until we added from 8 per cent to 10 per cent of tin. In making this aluminium-copper-tin alloy we found it necessary to make up a rich alloy, cast it into bars and add this alloy to the aluminium at the proper time. The use of these eutectic alloys we have found very effective in securing results otherwise difficult to obtain.

The problem of producing brass and aluminium parts which shall be more homogeneous, tough and perfect than could be produced by ordinary casting methods has led to the development of the pressed metal process. Briefly, the process is as follows: A blank of copper or aluminium bar of sufficient size to contain the amount of metal required in the finished part is heated to a fairly high temperature. This hot blank of metal is then forced into a steel mould of the exact design and dimensions of the desired metal part. Powerful hydraulic presses, giving pressures from 500 to 2000 tons per square inch, are used to force the metal into the mould. This enormous pressure raises the temperature of the metal in the blank and causes it to flow into every part of the mould.

The results which are obtained by this process of forming brass and aluminium parts are wonderful:

1. The most intricate shape of piece can be formed by this process. Even ordinary newspaper size of letters reproduce perfectly on the finished part.

2. The pressed metal parts are formed so accurately to size and their surfaces are so smooth that in many cases no machining is required on the part after it comes from the mould.

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3. Where machining is required, the parts are found to machine much more easily than parts cast by any known methods. The cutting tool might almost be said to become sharper when used in cutting the pressed metal. The pressed metal has no tendency to cause the edge of the cutting tool to crumble or break.

4. The pressed metal parts are absolutely free from air and gas holes and sand. Because of the freedom from such gas and air holes, parts such as gas nozzles can be made by this process.

5. The pressed metal parts are much stronger and tougher than parts cast from the metals in question. Pressed metal brass parts are as strong as bronze or English gun metal, and can, therefore, often be substituted.

As regards checking system and systems of running foundries and cleaning rooms, such systems and methods are being widely exploited in the technical papers. In this literature there is a wealth of information for the foundry superintendent or owner who wishes to keep abreast of such developments. The technical papers are also a reliable source of information on modern foundry appliances such as core ovens, moulding machines, electric and air hoists, electrical and mechanical sand riddles, acetylene and electric cutting appliances, torches, dust collectors, etc. These appliances, of course, cost money, but in the end they are unquestionably of value in labor-saving and in keeping good workmen satisfied and interested in their work.

Pyrometers for measuring the temperature of the molten metals are indispensable in securing uniformly perfect castings. Where the foreman or melter has to judge the temperature by his eyes, misjudged temperatures resulting in sluggish metal, with consequent porous or otherwise defective castings, are all too frequent, for the light in the foundry easily influences the decision of the melter as to when the metal has been heated to the correct temperature for pouring. The pyrometers eliminate such errors in judging temperatures and, we believe, therefore, their use cannot be too strongly recommended.

I feel, however, that it is in the melting end of the foundry itself that we must look for the greatest advances in the near future. I believe that all of the present methods of melting will soon be replaced by much more efficient processes, either electrical or burning a gas derived from a fuel oil base by some method of premixing in a retort rather than by pulverizing and dividing the fuel oil and mixing with air, which produces the nebulous form of gas now used. The advances that have been made in electrical furnaces, ovens and retorts lead me to expect that in the near future electricity will compete on favorable terms with the various fuels for foundry melting purposes. I believe there is no doubt that some of the great electrical men are investigating along these lines and the results of their research should be disclosed in the near future.

"Safety" in the foundry, we are glad to note, has become an accomplished fact in all of our modern foundries. A stock of goggles, aprons, leggings and special shoes for foundry work is usually kept in the works' storeroom. In some cases these supplies are checked out to the workmen, while in other foundries they are sold to the men at actual cost; in most cases the use of this special safety clothing is insisted upon by the foundry management, and there is no question that it is a practice that all foundries should follow.

The new **Ceramic Engineering Building** of the University of Illinois will be formally dedicated on November 21 and 22. An industrial conference will be held in conjunction with the dedication.

Principles of Industrial Organization

By H. N. Stronck

Industrial waste elimination is fundamentally based on analysis and synthesis. Chemists and metallurgists have a special training in these branches of science and for many years have applied the principles of analysis and synthesis to the technical branches of their industries. It has, however, been comparatively recently that these same principles have been applied to the organization and business branches of industries.

What is known as scientific management originated in steel plants, and the laws and principles of this new science were first discovered and applied in these industries. The classical papers of Frederick W. Taylor refer almost entirely to work in steel plants and allied industries.

The chemical industries were among the first in Germany to investigate and apply scientific methods to their organizations. In this country we now fully appreciate the control which the German chemical industries have of the production features of chemical manufacturing. The Germans, however, realized that in order to become more supreme, still further economic results could be obtained by eliminating all possible wastes of organization and management. German efficiency is now a by-word in our press. In analyzing this, we find that the German worker as an individual is not as great a producer as the individual in our American industries, but that the secret of their success lies in the highly efficient development of organization control.

To date, comparatively little has been done in applying the spotlight of analysis to our wastes of organization. We all realize that there is a great difference in the management methods of similar concerns, but very little has been accomplished in the development and application of a standardized and highly efficient method of organization and control in the large majority of our chemical and metallurgical concerns.

Analysis and Synthesis in Organization

Chemistry teaches us that by combining certain elements in the right proportion, a product of value results. Similarly, in management, a combination of well established principles, judiciously applied, will result in a high type of management. Therefore, in determining the status of an organization, we must compare it with principles which we know are right, and see where and to what extent these principles are neglected. We must diagnose present conditions. After the weak points have been found, these must be eliminated by the substitution of fundamentally correct methods, and the entire organization brought to a strong, concrete whole. This is synthesis.

In the past, the organization and development of large and successful businesses was done almost entirely by the forceful use of synthesis with very little conscious application of analysis; and as a result accidental organizations were developed which could not take care of sudden booms and slack periods, and in which the loss of one leader often produced disastrous results. Accidental organizations were the ones that broke down under the stress of changing conditions. However, in those days, there was a large margin of profit to draw upon. The wastes were great, but no greater than that of a competitor, and in order to be successful, the management of an enterprise need only be as good as that of its competitors. In the last fifteen years there has been a great development in the application of analysis to management problems.

The first step was in a desire to obtain the money value of different operations, and cost-accounting

methods came into vogue. The next step commenced when manufacturers began to realize that the day-work method of wage payment was not satisfactory and they commenced the introduction of wage payment systems based on effort. Here the time element comes into consideration. At first this time was determined by rule-of-thumb or guess-work methods, and finally the new and scientific method of time-study was evolved and is gradually superseding the old guess-work methods of determining how long it should take to perform an operation. This time-study method of analysis taught us many other things, such as, that our methods of handling materials and the routing of materials and tools, were in a wasteful state; that our buildings were not designed in a manner to encourage greatest efficiency; that our machines were not placed in such positions that the distance of travel of the material through the processes of manufacture was not at a minimum; that time losses occurred due to incomplete instructions issued to the operating department by the office; that too much planning was done in the shop and not enough in the office, etc. The more analysis was applied, the greater the field of its application developed, until to-day it is applied to all steps of operation from the purchase of the raw material to the delivery of the finished product to its destination. As a result, new and elastic organizations were built up, which grow naturally as the business grows.

For the purpose of visualizing the problem, this article will endeavor to show just what points must be considered in developing a high type of organization.

Fig. 1 shows the functions and sub-functions of organization.

Fig. 2 shows the functions of operation and the relationship between these and the other functions.

The Function of Planning

The most important function of any organization is that of planning. In order to obtain the highest results of operation, the planning function must be developed to a highly efficient basis. The success of any organization is dependent upon the thoroughness and practicability of its plans. The degree to which planning should be carried out depends considerably upon the type of industry and the personnel of which it is composed. The ideal is to have a strict division between planning and operation. This ideal is difficult of attainment in practice, however it should be constantly borne in mind and approached as closely as is practical.

In our chemical and metallurgical industries, planning is divided into two main divisions, technical and operative. Because of the highly technical features of these industries, the technical branch of planning must be well developed, for the function of operation is greatly dependent upon the efficiency of the technical plans. Our chemists and metallurgists are well trained in the technical features; and hence, in the successful industries of this type, the technical planning is on a sound basis. The general lay-out of operation is based on technical planning. It is in this function that the start is usually made in the upbuilding of an organization for these industries.

It is the function of technical planning which answers the question of WHAT is to be done. This consists of the development of the standard formulas of what is to be produced, and in part of planning methods which will produce a result in accordance with these formulas. After these standard formulas have been developed, research planning must constantly be in progress to improve these standards, and in addition, to the development of new formulas preparatory to producing new products which may have an economic value.

In these industries, the function of technical planning must also include the function of testing. This function must be in close co-operation with the main functions of purchasing, operation and sales. Purchases must be made in accordance with the specifications made by the planning department. When the material arrives, tests must be made to ascertain whether or not the material received complies with the purchase specifications as to quality. During the process of operation, tests must be made at the various stages, to determine how closely the function of operation adheres to the instructions of the planning function. Before a product is placed in charge of the sales function, tests must again be made to assure that the product conforms with the sales specifications.

A general analysis of the management features of chemical and metallurgical industries has shown that many of the weak points are the result of the insufficient development of the operation branch of the planning function. To promote sound management, it is equally important to have definite, standard methods of operation planned in advance. These plans must be made by persons especially fitted for this class of work, and not left entirely to the judgment of the foremen or gang bosses in each department. Because in the past this feature has been left to the judgment of each de-
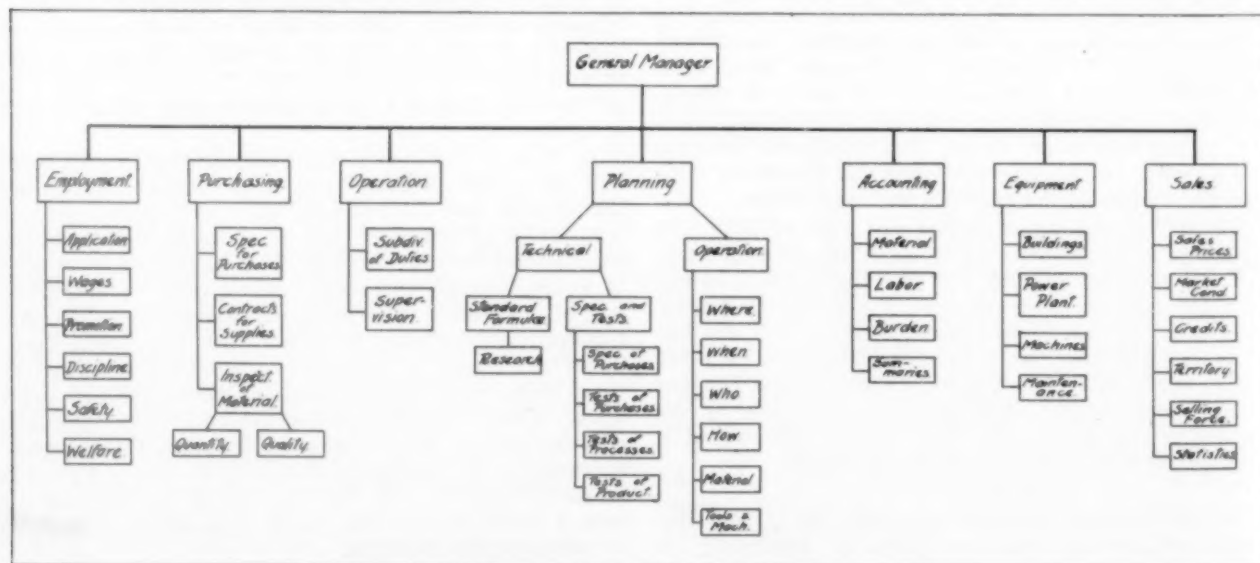
FIG. 1—FUNCTIONS OF ORGANIZATION

partment head, a great unevenness in the operation features of the different departments has developed, and rule-of-thumb methods are in vogue rather than scientific methods.

Importance of Time Element

All other things being equal, the efficiency of an operation is dependent upon the speed of the operation; in other words, the time element is of great importance. Assuming the quality to remain the same, the cost of an operation decreases as the time decreases. Hence the problem of importance in cost reduction work is the problem of time reduction. Since time is such an important feature, an analysis of the time required to perform each operation is necessary. The most scientific method of time analysis is by means of the decimal stopwatch, and by what is known as elementary time-study. According to the elementary time-study method, the total or over-all time of an operation is not taken as such, but each operation is divided first into its elementary component parts and the time of each element obtained. In the analysis of an operation by this method we find, in most instances, that a number of the elements are avoidable and can be eliminated. After all unnecessary elements are eliminated, a new cycle of elements of least waste is synthesized from the data sheet, and this new cycle of elements, or motions, is taught to the workers. This is the basis of all time-study research work and it is by this method that so many astounding results have been produced in almost all industries and in almost all classes of operations. It is from these data that standard operation instructions are issued and on which the incentive wage-payment methods are based. It is this standard time on which operation efficiencies are based.

In the chemical and metallurgical industries, however, we find a large number of process operations in which the time element is beyond the control of the operators. On such operations, the important feature, from a labor standpoint, is the strict attention to the instructions which govern the operation of the process. The process operation must be closely supervised, otherwise the product will be inferior to the standard requirements. In such cases, the incentive wage payment method is not based on the time reduction, but on the strictness of the regulation of the process, which governs the quality of the product. For example, in a certain instance, the quality of the product of a process was governed by the specific gravity of the mixture during the operation. To insure high quality of product, a specific gravity was necessary which was not allowed to fluctuate beyond certain fixed limits. Periodic tests were made each day. On each day that these tests indicated that the specific gravity was kept within the limits, a bonus was paid to the operators. In this instance, the efficiency of the operating force was measured by the fluctuation in specific gravity.

Methods Which Tend to Increase the Efficiency of Each Function or Sub-Function

As stated previously in this article, in order to determine the status of any organization, a comparison of principles which now exist should be made with the fundamental principles and laws of management which we know hold true for any industry. These laws or principles of management have been stated in somewhat different form by various authorities, but a comparison and analysis of the statements of the various authorities shows that fundamentally their ideas are the same. The difference is merely a difference in the form and completeness of the expression of their principles. We are all more or less familiar with what Taylor calls the "Principles of Scientific Management," Emerson the

FIG. 2—FUNCTIONS OF OPERATION

"Twelve Principles of Efficiency," Gillette the "Laws of Management," etc. These principles, or laws, are of great aid in the visualization of the problems of management and in the critical analysis of present conditions. Each law or principle should be 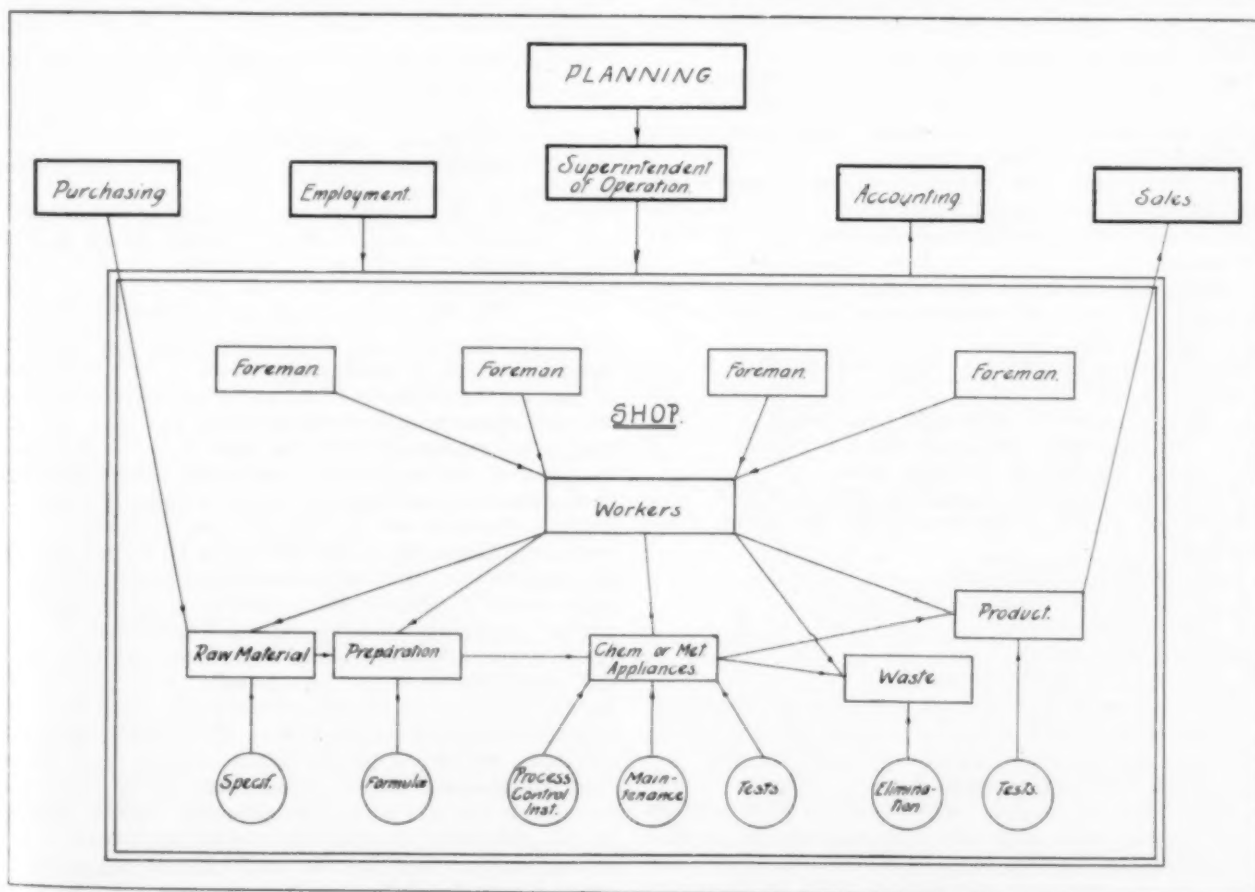thoroughly studied, and then an analysis made of the present organization, so as to determine if each of these laws, or principles, is recognized and applied in the present organization to the fullest possible extent.

The above laws apply, in general, to an analysis of the human element of industrial work. The material element must be analyzed somewhat differently, but definite laws also have been formulated to analyze these problems. In order to give a concrete example of analysis and application, the function of material or stores will be used as an illustration. It is believed that the method which follows is applicable to any and all forms of industrial organizations where materials are in use.

Analysis of Problems Which Relate to Materials

The laws which relate to materials are stated by Duncan as follows:

1. Materials must be purchased from the lowest priced firms when materials are at their lowest prices.

2. Materials must come up to their contracted excellence in quality.

3. The quantity purchased must be obtained.

4. Materials must be delivered at the specified time.

5. Materials must be properly housed and stored.

6. There must be no unnecessary waste of material.

7. No losses must occur except through waste.

Now that we have a definite basis with which to study the material problem, the next step is logically the development of functions and a mechanism to insure that these laws are carried out. If we study these laws it will be seen that laws 1 and 4 arrange themselves naturally under one function, that of purchasing, which means that in order to live up to these two laws, we must have a well organized purchasing department.

Laws 2 and 3 deal with the function of inspection, and hence the organization of an efficient receiving and testing department should commence to insure the proper fulfillment of these laws.

Law 5 circumscribes the physical conditions which surround materials when once received and leads to the establishment of a proper stores system with accurate accounting.

Law 6 refers to wastes of issuance, and hence an adequate control system of issuance must be designed which fixes responsibility.

Law 7 refers to losses of maintenance of materials while in use and during the action of placing them in use. The function to safeguard such losses is a function of maintenance, and hence the establishment of a maintenance department becomes necessary.

We now have in view the establishment of five functions to insure the enforcement of the seven laws, namely:

1. Purchasing department.

2. Receiving and testing department.

3. Stores department.

4. Issues and reports.

5. Maintenance department.

The next logical step will be to design and introduce a mechanism for each function, so that the laws which pertain to that function are automatically enforced. Although the laws are constant for any industry or any condition, the mechanism with which to enforce these laws will vary with each problem; in some instances a very simple mechanism may be a safeguard, while in other cases a complex mechanism must be designed. The following covers certain points in the design of any mechanism which should be given careful consideration. It is not the object of this article to discuss these in detail, but they are only intended to serve as a guide.

PURCHASING DEPARTMENT:
  a. Catalog files.
  b. Price lists.
  c. Special quotations.
  d. Economic amounts to purchase.
  e. Book of standards.
  f. Purchased orders with promised delivery dates
  g. Reminder file.
  h. Efficient filing system.

RECEIVING AND TESTING DEPARTMENT:
  a. Quantity tests by receiving clerk.
  b. Quality tests by inspector.
  c. Notification that goods have been received.

STORES DEPARTMENT:
  a. Properly arranged warehouses.
  b. Stock piles.
  c. Standard bins.
  d. Mnemonic classification.
  e. Stores records (perpetual inventory).
  f. Maximum quantities.
  g. Minimum quantities.
  h. Bin tickets.
  i. Checks.

ISSUES AND REPORTS:
  a. Requisition issue.
  b. Budget method.
  c. Extraordinary expense method.
  d. Unit record of consumption.
  e. Special accounting methods.
  f. Graphic charts.

MAINTENANCE DEPARTMENT:
  a. Prevent loss by misplacement or theft.
  b. Prevent deterioration.

In addition to the physical aspect of the material problem, we must contend with the human factor. A considerable part of the waste of materials is directly chargeable to the human factor. Certain definite laws should be followed to reduce this waste, and the following laws will serve as a guide in an analysis of these wastes: In order to reduce wastes of material due to the human factor, we must have:

1. All work carefully planned in advance.

2. Specifications as to the best materials and tools to be used.

3. Carefully drawn instructions of how to use and apply the tools and materials.

4. Materials and tools must be delivered to the worker in the standard condition specified.

5. Competent instructors to teach and aid the worker to follow these instructions.

6. Individual records of each worker as to results.

7. Extra pay when work is carried out as per instructions.

The Effective Growth of a Function

The preliminary plans of any industrial enterprise, or function of such an enterprise, are based on a knowledge of past attainments, that is, on experience. The men who commence a successful undertaking, have, in general, a knowledge of what has been done in that field of endeavor and how it has been done. This knowledge is the basis of the building up of a function, and the development of a routine for carrying on the work of a function. Hence the starting point is to accumulate experience. The first experience accumulated consists generally of the knowledge gained by personal work, or contact in the past with work, relating to that particular function. The second is experience gathered from the outside, what other industries of a similar nature have done or are doing, data from technical publications, and consultation with experts in that particular field.

This is the era of specialization. The average industrial enterprise consists of many functions, and it is impossible for one man to accumulate, classify and apply all the experiences of every function. This is the strongest argument for the staff type of organization, which has replaced the line type in many industries. In the staff type of organization, the functions are dis-

tinctly separated, and at the head of each function there is placed an individual or a staff, whose duty it is to become an expert in this particular function only. His authority and work does not conflict in the least with that of another function, and he is responsible for the work of his function to the general manager only, and to no one else. An enormous amount of experience is now available in any function, and if an individual is made responsible for one function only, he will have time to gather a wealth of experience in this function; and similarly the heads of all other functions. As a result, the enterprise as a whole will have at its command a large bulk of accumulated experience on which to base its plans and policies.

After experience has been accumulated, the next step will be the standardization of this experience, so that it can be successfully applied. This process of standardization consists of an analysis of the data obtained, and from this analysis to build up, or synthesise, a working method particularly applicable to the local peculiarities of the function involved. Carefully drawn plans, based on definite standards, are one of the greatest waste-elimination tools.

The third step consists in the application of this accumulated and standardized experience. During the process of application, the accumulation of further experience must be carried on as strongly as ever before. We accumulate considerable experience of our own during the process of application. This experience we may find to be similar to that which we have already gathered from other sources, and may not suggest new standards. In general, however, each case has its own peculiar local conditions, and details may develop from personal experience during the application, which are entirely dissimilar from anything of which we have a record ,and may result in many improvements of standards. Therefore, the entire object is to establish definite standards, and then endeavor to improve these standards, by observation, assimilation, and application of further experience.

As we have seen that an industrial enterprise is divided into many functions, so an analysis of each function shows that it consists of various sub-functions; in other words, a further division of the work of each function becomes necessary. For example, in the operation function, under modern industrial conditions, we seldom find one individual or group of individuals perform all operations which tend to make a completed product.

The greater the number of functions and sub-functions, the greater will be the division of responsibility of the organization as a whole, and hence the next important principle to consider is that of co-ordination. Co-ordination is the control of division. As the work of each function must be so regulated that it will harmonize with the results of the work of the other functions, similarly the work of each sub-function must be so regulated and controlled, that the result will be a smoothly run organization mechanism as a whole. The greatest waste of improper co-ordination of work is that of time. Hence to improve and assure proper co-ordination a careful analysis should be made of the time required to perform the units of work of each sub-function and apply the data obtained in balancing the work. The knowledge of the time required to do the work, is really the basis of the proper division of the work, and again forcibly brings to our attention the importance of time-study analysis.

The growth of a function has now been traced from the accumulation of experience, its standardization and application, the division of work and the proper co-ordination of the divisions or sub-functions, so that at this stage of the growth, the work of a function is supposed to be well balanced and regulated. The prime element of any industrial mechanism is the human element. It is the effort of the human element which carries on the work of the organization and assures that the industrial mechanism is kept in operation. To insure the proper and constant working of the organization, we must have proper conditions under which to carry on the work, reward this effort of the human element, and foster the growth of efficiency of this effort. In other words, we must promote personal effectiveness.

Personal Effectiveness

The study of the development of personal effectiveness is the most recent in industrial fields. The first division of this subject, which has been given considerable attention of late, is that which relates to the external conditions of the workers, or to the physical conditions of the surroundings of the workers. The divisions of this subject, which have been studied and applied to a greater or less extent in various industries, are enumerated below:

1. Atmospheric conditions:
    Freshness of air.
    Temperature.
2. Light:
    Quantity.
    Angle.
3. Quiet.
4. Freedom of movement.
5. Sanitation:
    Cleanliness.
    Brightness.
    Appliances:
    Latrines.
    Washing facilities.
    Clothes lockers.
    Pure drinking water.
6. Safety:
    Fire:
    Sprinkler systems.
    Fire drill.
    Systematic inspection of emergency doors, stairways, etc., and of the alarm and fire fighting apparatus.
    Machinery:
    Surround dangerous parts in motion, with a protecting barrier. Place barriers around elevator shafts, openings in floors, etc.
    First aid:
    Properly drilled first-aid teams.
    Medical service.
    Emergency hospital.
7. Compensations:
    Accident.
    Sick and benefit funds.
    Pensions.
8. Accessory conveniences:
    Meal rooms.
    Rest rooms.
    Bath rooms.
    Club rooms.
    Libraries.
    Etc.

The second part of the subject deals with the study and analysis of the inner qualities of the personnel of an organization. This involves the analysis of the special human faculties necessary to fill certain positions in the most efficient manner, and an analysis of the candidates for the position, as to whether or not they possess the required faculties. The pioneer in this field of endeavor is Professor Hugo Muensterberg, but to date so very little has been done in this field that it is as yet impossible to formulate any definite rules which would apply to all cases. It may be stated, however, that a great aid in the discovery of whether or not a worker is fitted for the work, is the knowledge of the best method and time for each job, and with these data as a base, shift the workers to such work as they can accomplish in the time set, and thrive under it. This has a very practical application in those industries which are now operated under scientific management. Records of performance of workers on various jobs are of great aid in the selection of workers for jobs. However, there are so many other elements which enter into this problem, that the field still has unlimited opportunities for research. We all realize that one of the great-

est wastes is caused by the physical and mental unfitness of workers for the work which they now perform, but at the present state of the development of the science, the solution of the problem is still faced with many difficulties.

After the surrounding conditions and the environments of the work have been so regulated as to foster the growth of personal effectiveness, and after the correct type of personnel has been selected for each type of work, the next step in the growth of personal effectiveness will consist of the development of that co-operative feature, which is commonly known as team-work. A study of the team-work of an organization comprises the analysis of the mass as a whole, and the mutual relations between the individuals which comprise this mass. The conscientious application of the principles of scientific management tends to promote this team-work. One of the simplest definitions of scientific management is "dignified team-work between employer and employee." Where the ideals and policies of an organization are of a high degree and compatible with the belief of a large majority of individuals, there is produced among the members of that organization what may be termed a group-pride. Individuals are proud to be members of that group, and group spirit is developed and fostered. The individual must have a firm belief and confidence in the leadership of the group and he must be impressed with the superiority of that group over other similar groups. The individual must have a firm belief in the purpose of the work of the group. There are numerous illustrations of this principle, such as racial pride, pride of nations, of fraternal organizations, of athletic teams, of universities, etc. When the spirit of the group is inculcated in the individual and each individual realizes that his effort aids in promoting the aim of the group, then we will have true team-work of the group. It is rather difficult to state just how this can be accomplished in every type of industrial organization, but justice, fair treatment, firm belief and confidence in the leaders, and recognition of effort are the main forces which will produce it.

Recognition of Personal Effort

Nothing will promote personal effectiveness more than will recognition of effort of the individual. The practical application of the recognition of effort in industrial organizations is the application of incentives or rewards proportional to the effort expended and the results produced. An incentive is that which incites, or tends to incite, to action. The part which incentive plays in the doing of all work is enormous. Incentives may be a definite or indefinite return of some kind. Punishment may incite action, but whether this action is detrimental or not, depends upon whether or not the right kind of punishment is administered. It has been noticed, however, that the greatest cause for cutting down work is related more closely to a reward than to a punishment.

Under industrial management, rewards are usually promotion and pay, the word pay including regular wages, bonus, shorter hours, or other forms of recompense. Punishment may be negative, that is no reward, or positive, that is, a fine, discharge, or shifting to less desirable work. In order to produce the greatest amount of incentive to action, rewards must be definite and positive gains to the individual. The individual must definitely know just what the reward will be before the work is commenced; that reward must be personal, i.e., there must be a reward for that particular person for that particular work; the individual must get exactly what was determined before; the individual must be positively assured that he will get the reward; as soon as the work is done, the individual must get the reward.

These points must be kept well in mind in the design of wage systems. They also serve as guides in the analysis of existing wage systems. Only in so far as these points are adhered to, is the wage system highly efficient.

The number of different types of wage systems in use at the present time in industrial organizations are so numerous as to be beyond the scope of this article. They all, more or less, strive to adhere to the points enumerated, and their efficiency may be determined by the number of these points which they actually cover. Wherever possible, some standard wage system, which we know has been very effective in a number of cases, should be applied. However, in a great many of our industries, the conditions of work and kind of work are so varied, that it is almost impossible to apply one form of wage system successfully to all cases. Hence, some organizations have several different forms of wage systems in use. It may be found that due to local peculiarities of the work and labor conditions, it is impossible to apply any of the standard wage systems as a whole. This may lead to the design of a special system of remuneration especially applicable to the conditions involved. The principles pertaining to the effective growth of functions have been admirably stated by Church in what he terms the "Laws of Effort."

A Few Additional Points

As previously stated, the tendency of industrial organization is to organize according to the staff plan and this plan is replacing the line type in many organizations.

According to the staff type of management a complete classification of the work is made according to functions and an expert is placed at the head of each function who is responsible for the work of that function only. A sharp line of authority and responsibility is drawn.

It is a well recognized principle that the highest efficiency is obtained by the separation of planning from performing and this is brought about by the staff type of management. Although these lines may be drawn very sharply, theoretically, still there must be enough mobility and quickness of action so that emergency cases may be taken care of in the shortest possible time. A good manager is one who knows how and when to transgress from fixed methods of standard routine to take care of emergencies. A classification of all possible emergencies will serve as a guide to plan ahead definite methods of taking care of such emergencies and increase the rapidity of action.

One of the greatest emergency problems in any organization, is the sudden and unforeseen loss of some valuable member of the organization. A method known as the "Three Position Plan" is now in use by large and progressive organizations. According to this plan any member of the organization really holds three positions.

1. That of WORKER in his present position.
2. That of TEACHER to the member the next step lower in the organization.
3. That of STUDENT of the position the next step higher in the organization.

A chart is then drawn which indicates definite lines of promotion. Such a chart acts as an incentive to all members of the organization. A rule is also made that no member is promoted to the next higher position until his understudy is capable of filling the position.

In designing the lay-out of an organization, what is termed the "Exception Principle" must also be kept well in mind. This, briefly stated, is as follows:

1. Sub-divide work in such a manner that no high-priced employee performs work which can be performed by a lower priced employee.

2. Exceptional cases only should be brought to the attention of the higher officials.

The application of this principle involves the standardization of work and the determination of limits. As long as work is normal, the higher officials need not worry. However, as soon as the work, or results, pass out of the fixed limits the attention of the higher officials is automatically brought to this divergence from the normal.

Another valuable principle is stated by Mr. H. L. Gantt as follows:

"The authority to issue an order involves the responsibility to see that it is properly executed."

According to Mr. Gantt, adherence to this principle eliminates that class of managers, unfortunately too common, who like to shift the responsibility for their errors to their subordinates. By the elimination of such men, authority gravitates slowly, but surely, to those with knowledge, and we finally have a condition on which authority is based on knowledge and ability to use that knowledge. In other words, orders are given to accomplish results, and they should be given only when results are possible; in such a case no excuse for failure should be accepted.

In conclusion, it is only by the proper subdivision of work, effort and responsibility, the training and developing of leaders in each function, and the proper co-ordination of the work in all functions, that we obtain true and lasting industrial efficiency.

Benedict, Boyle & Stronck,
  Chicago, Ill.

Apparatus Exhibit.—The L. E. Knott Apparatus Company, of Cambridge, Mass., will hold an exhibition at the opening of its new building during Thanksgiving week. The company makes a specialty of American made laboratory apparatus and has recently secured the agency for electric furnaces, hot plates and pyrometers manufactured by the Hoskins Mfg. Co., Detroit, Mich. Invitations have been issued to all the schools and colleges in the vicinity to attend the exhibition and a general invitation is extended to the public.

Soapstone.—In the production of soapstone the United States ranks first among all countries, and Virginia produces about 20 times as much as the four other producing states—Maryland, North Carolina, Rhode Island and Vermont. The waste from breakage in quarrying, sawing into slabs, manufacturing and final transportation is so great as to render success in the industry a matter of skillful manipulation. The value of the stone is in large measure proportionate to the work done upon it. In the rough it is valued at $2 or less a ton, but when sawed into slabs its value is increased to about $15, and when made into laundry tubs it may attain a value of about $30 a ton. The production of soapstone and talc in the United States is steadily increasing, according to the United States Geological Survey, Department of the Interior. In 1900, it was 27,943 short tons, in 1910 it was 150,716 tons, and in 1915 it was 186,891 short tons.

Artificial Gas.—The quantity of artificial gas—oil and water gas and coal gas made at retorts and by-product coke ovens—marketed and sold in 1915, was 266,204,248,000 cubic feet, valued at $173,832,132, according to statistics collected by C. E. Lesher, of the United States Geological Survey, Department of the Interior. This was an increase of 25 per cent in quantity and 17 per cent in value, compared with 1912, the next preceding year for which the statistics of this industry were collected by the Geological Survey.

The Processes of the Organic Chemical Industry as Used in the Manufacture of Intermediate Products

By A. H. Ney & D. J. Van Marle

Reductions

When in a chemical reaction oxygen is eliminated, hydrogen added, or oxygen replaced by hydrogen, this reaction is called a reduction. As an example of the elimination of oxygen without the addition of hydrogen, the reduction of nitrobenzene to azoxy and azobenzene will serve, whilst notable cases of the addition of hydrogen without other change in the molecular composition are the reduction of quinone to hydroquinone by means of sulfur dioxide, and of oleic acid and triolein to stearic acid and tristearin by means of hydrogen in the presence of reduced nickel—this latter reaction forming the basis of a large and growing industry.

The most important reductions from the technical standpoint, however, are those of the third class in which oxygen is both eliminated and then replaced by hydrogen, the chief class of bodies in which this reduction is commercially practised being the nitro-compounds, which are thereby converted into amido-compounds, the oxygen in the nitro-group being replaced by hydrogen. This reduction of nitro-compounds does not take place at once, but a number of intermediate products are formed, depending on the conditions during the reduction, all of which are ultimately converted into the amido-compounds.

In an acid medium first the nitroso-compound is formed, then the hydroxylamine-compound, but these intermediate products are reduced so quickly that they cannot be detected in the mixture. These two compounds also can react together and form an azoxy-compound, which on further reduction gives an azo-compound, then a hydrazo-compound which in acid medium is also reduced to the amido-compound.

In an alkaline medium, however, especially when zinc is used as a reducing agent, the reduction does not go so far and the hydrazo-compound is formed besides a small amount of the amido-compound.

The hydroxylamine-compounds, which also are of importance, can be obtained by reduction with zinc in neutral solution or concentrated sulfuric acid, and are converted by acids into para-amido-phenols.

All the intermediate products mentioned can be prepared by electrolytic reduction of the nitro-compounds, but as the necessary apparatus is complicated, and as they can be obtained also in a different way, the electrolytic way of preparation has not found any technical application, even if it has the advantage that the products have not to be separated from any reducing agents.

The intermediate products therefore do not interfere with the result of the reduction, which yields one definite reduction product, when starting from a pure nitro-compound. We only obtain a mixture of different products when we start from a mixture of nitro-compounds, as is done for instance in the case of the naphthylamine-sulfonic acids, which are made by nitration and reduction of the crude mixture, resulting from the sulfonation of naphthalene.

The reducing agents used on a large scale are iron, zinc and sodium-sulfide, others being too expensive. For a few preparations tin is used, and in such cases the tin has to be recovered.

Iron is used for the manufacture of amido-compounds directly from nitro-compounds, in the presence of an acid, either hydrochloric or acetic acid.

If the reduction were only effected by the hydrogen formed from the iron and the acid, a large quantity of acid would be required, whereas in practice only 2 to 3 per cent of this quantity is used. The reason is that a ferrous salt is formed, which itself is a reducing agent and which is converted into an oxychloride if hydrochloric acid is used. This oxychloride is acted upon by the iron, forming black iron oxide, while at the same time ferrous chloride is regenerated, which can reduce another quantity of the nitro-compound, the hydrogen necessary for the preparation of the amido-compound being supplied by the water, and in case acetic acid is used a reaction of similar nature takes place. This not only saves a large amount of acid, but also makes it possible to carry the reaction out in iron reducers, as the solution of ferrous chloride is only slightly acid and therefore does not corrode the apparatus. The amount of acid cannot be reduced any further as then the reduction would become so slow that too much time would be lost.

Where iron is not suitable it can be replaced by zinc dust which is used for the reduction of certain nitroso-compounds, amido-azo and oxyazo-compounds, which are converted into amido, diamido-compounds and amido-phenols, respectively, but here it is not possible to use such a small amount of acid. Examples are the reduction of nitroso-dimethylaniline to dimethyl-para-phenylenediamine, of amidoaozbenzol to para-phenylenediamine and amidoazotoluol to para-toluylene-diamine. Of much more importance, however, are the reductions with zinc-dust in alkaline solution, when hydrazo-compounds are formed as the main product of the reaction. These hydrazo-compounds are converted into diamido-compounds of the benzidine class by boiling with acid, which discovery has led to the development of the large class of azo-dyes which can be dyed directly on cotton. The three products of this class of the most importance are benzidine, tolidine and dianisidine, made from nitrobenzol, ortho-nitrotoluol and ortho-nitro-anisol.

In a few instances sodium sulfide has found application. It has the peculiarity of reducing only one nitro-group in dinitro-compounds, so that starting from dinitrobenzol we can obtain with iron meta-phenylenediamine, and with sodium sulfide meta-nitraniline. It has been found that in case other groups are already present, the nitro-group in ortho-position to a hydroxyl-, amido-, chlorine- or oxy-methyl group is reduced, and the one in para-position to a methyl- or carboxyl-group, the other of the two groups being protected.

The temperature is a factor of small importance, most reductions being carried out at 80 to 100°-C. The reaction is started with only a small quantity of both the nitro-compound and the reducing agent, which are heated together. As soon as the reduction begins, both products are gradually added, and the heat which is developed then is sufficient to keep the reaction going. If too large quantities were put together, so much heat would be generated that even an explosion might follow. It is therefore advisable always to have the reducing agent present in excess, so that the nitro-compound never can accumulate, and the reduction is entirely controlled by the adding of the nitro-compound. The only reason that not all the iron or zinc is put in at once is that this would mean a great strain on the agitator, and more power would be required for the agitation than necessary. The factors which determine the result of a reduction are therefore quite different from those in the case of a nitration. Whereas in the latter case the result depends on the amount of nitric acid used and is otherwise pre-determined by the nature of the product to be nitrated, in the former we obtain different results by the choice of the reducing agent, and of the medium in which the reduction is carried out.

Application

The amido-compounds in their relation to the nitro-compounds and raw materials, from which they are produced, have been already described in the chapter on nitrations. Their largest application is found in the manufacture of azo-dyes, due to the property they have of forming diazo-compounds with sodium nitrite in acid solution, which can be combined with amido- and hydroxyl-compounds, which are generally designated as azo-compounds.

On account of the large number of combinations which can be made, the azo-dyes form the most numerous class of dyes, several hundred of them having found application, for azo-dyes can consist of more than two compounds, which increases the number of possible combinations enormously. When a diazo-compound is combined with an azo-compound first an intermediate product is formed, which in many cases, where the combination takes place slowly enough, has been isolated. With an amido-compound the combination takes place between the nitrogen atoms of both compounds, forming a diazo-amido-compound which later by intermolecular rearrangement is converted into an amido-azo compound. With a hydroxyl compound the combination takes place so quickly that the intermediate product cannot be isolated, and the oxy-azo-compound is formed immediately, but there is little doubt that it is formed, and in one case, that of beta-naphthol-ortho-sulfonic acid its existence has been proved. In all azo-dyes the azo-group is placed either in ortho- or para-position to the amido- or hydroxyl-group of the azo-compound of which the para-position is preferred, the two classes being distinguished as ortho- and para-azo-dyes. Ortho-azo-dyes, which have generally more desirable properties, can therefore only be formed when the para-position is already occupied. The para-oxy-azo dyes are of little value as they are not fast to acids, but the para-amido-azo-dyes are valuable, as they contain an amido group which can again be diazotized and combined with another azo-compound.

The first class of azo-dyes are the mono-azo-dyes obtained by combination of a diazo-compound with one azo-compound, the simplest being amido-azo-benzol or aniline-yellow, made by diazotizing aniline and combining the diazo-compound with aniline. It is a para-azo-dye and therefore of little value as a dye, but it is used as an intermediate product for the more complicated azo-dyes. From toluidine, xylidine and alpha-naphthylamine similar compounds can be prepared, while the one from diazo-benzol and alpha-naphthylamine has also found much application.

The most important dyes of this class are made with sulfonic acids of the naphthalene-series, which on account of their acid nature have generally found application as wool-dyes, and only in a few cases are applied to cotton with a mordant, but these are mostly replaced by others with more desirable properties. To this class also belong a number of dyes, used as lakes and pigments, mostly containing beta-naphthol as the azo-compound. Of these para-nitraniline-red made from diazotized para-nitraniline and beta-naphthol has the largest production, and is used both for cloth-printing and for paints in enormous quantities. To dye it on cloth directly it is necessary to

prepare the dye on the cloth, which is done by first treating it with an alkaline solution of beta-naphthol, and then with the diazotized para-nitraniline.

The disazo-dyes contain three compounds, and can be subdivided in three groups. The primary disazo-dyes, which are made in one operation and can be prepared either from one diazo-compound with two azo-compounds or from one azo-compound with two diazo-compounds. For the first group it is necessary that the diazo-compound contain two amido-groups, which are both diazotized, and as both groups combine with a different speed, it is possible to combine it first with one, then with a second azo-compound. Benzidine, tolidine and dianisidine have this property, which has led to the development of one of the most important classes of azo-dyes, and as they have in addition the property of dyeing cotton directly, they are generally known as direct cotton dyes.

With para-phenylene-diamine this is not possible, but here we can obtain the same result by first preparing a mono-azo-dye from acetyl-paraphenylene-diamine, and saponifying it, or by reducing a dye made from para-nitralinine and re-diazotizing this dye, which now contains an amido-group, and combining it.

A number of azo-compounds, like alpha-naphthol, resorcine and meta-phenylene diamine are able to combine with two diazo-compounds, as are some of the amido-naphthol-sulfonic acids, especially H. Acid. These acids contain both an amido- and a hydroxyl-group, and when we first combine in acid solution the diazo-compound will enter in ortho-position to the amido-group, while entrance in ortho-position to the hydroxyl group is prevented by the acid, after which we can combine this intermediate product in alkaline solution, the diazo-compound now entering in ortho-position to the hydroxyl group.

The secondary disazo-dyes are made in two operations, first a para-amido-azo dye being prepared, which is rediazotized and again combined. The most frequently used amido-azo-dyes are amido-azo-benzol, amido-azo-toluol and their sulfonic acids and those containing alpha-naphthylamine, Cleve's alpha-naphthylamine-sulfonic acids and Gamma acid, as middle components.

It is obvious that the disazo-dyes containing an amido-group can be diazotized again, thus leading to the trisazo- and tetrazo-dyes, which are still more numerous, but of which fewer have found application. Often these trisazo-dyes are formed on the fibre, after the cloth has been treated with the disazo-dye, thereby giving it a more desirable shade or a greater fastness. The amido-azo-dyes in this case are diazotized on the fiber and combined, mostly with beta-naphthol, meta-phenylene-diamine or meta-toluene-diamine; the oxy-azo-dyes are developed on the other hand with a solution of diazotized para-nitraniline.

The amido-compounds often are converted into other intermediate products. Aniline is the most important, and besides being used in large quantities in the rubber industry is the starting material in the production of amido-azo-benzol and its sulfonic acids, dimethylaniline, nitroso-dimethylaniline, diphenylamine, acetanilid, para-nitraniline, para-phenylene-diamine, sulfanilic acid, hydroquinone and a few other intermediate products of minor importance. Large quantities are also used for aniline-black dyeing, the aniline being oxidized with bichromate of soda, and for the production of a number of other dyes, such as fuchsine, aniline blue, induline and nigrosine.

Of the toluidines, ortho-toluidine is used in the manufacture of amido-azo-toluol, safranine and sulphur-blues, para-toluidine for para-fuchsine, aniline-blue and primuline-dyes.

Metanilic acid, when fused with caustic soda, is converted into meta-amido-phenol, the base for the Rhodamines, which are important silk dyes. Anthranilic acid or ortho-amido-benzoic acid once was of importance in the preparation of synthetic indigo.

In the naphthalene-series alpha-naphthylamine and its sulfonic acids are most valuable, both in the manufacture of azo-dyes and as intermediate products in the production of alpha-naphthol and its sulfonic acids and the amido-naphthol-sulfonic acids. The sulfonic acids of alpha-naphthylamine are partly obtained by direct sulfonation of alpha-naphthylamine, as is naphtionic acid, and partly by reduction of the nitro-naphthalene-sulfonic acids. In the last case mostly a mixture of different acids is obtained which can be separated by their different solubilities, often not without difficulty. Beta-naphthylamine and its sulfonic acids on the other hand are prepared in an entirely different way by heating beta-naphthol and its sulfonic acids with ammonia under pressure.

The field of application of amido-compounds and their derivatives extends also in other directions besides the dye industry. Among medicinal compounds, for instance, such synthetic antipyretics as acetanilide, phenacetine, triphenine, phenocoll, neralteine and antipyrine, and the cocaine substitutes, anæsthesine and novocaine, all contain amido or imido groups which have been formed by reducing nitro-groups at some stage in their manufacture. The final step in the production of the valuable antiparasitic salvarsan is also a reduction, the reducing agent in this case being sodium amalgam, whilst the products pyramidone and trigemine, which have useful analgesic properties, and are manufactured from antipyrine as a starting point, obtain their extra amido group by the reduction of a nitroso group by means of sodium sulfide.
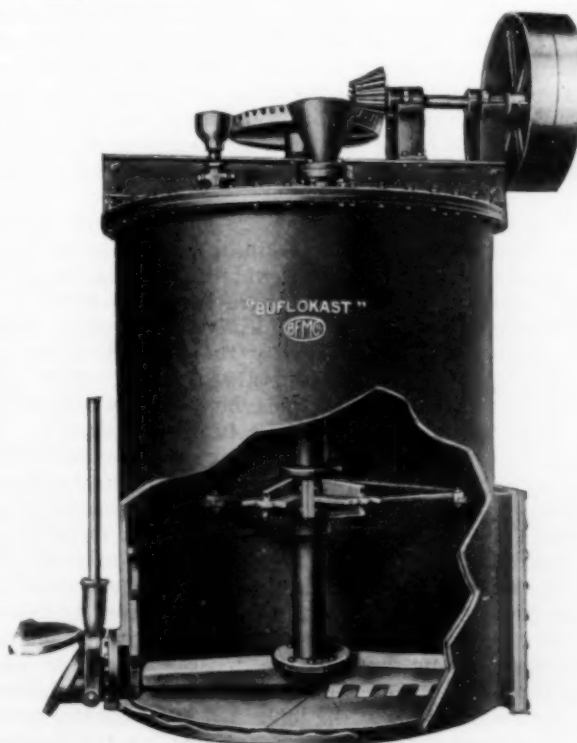
1600-GALLON REDUCER

Many amido-compounds, which also contain one or more hydroxyl groups have the feeble reducing power necessary to change silver photo-halides to metallic silver, and hence are used as photographic developers. Most of these have one amido group only, such as rhodinal or para-amido-phenol; metol, its methyl compound; edinol or para-amido-saligenine; glycine or para-oxyphenyl-glycocol; ortol or ortho-methyl-amido-phenol and eikonogen or 1.2 amido-naphthol 6 sulfonic acid, while a few like amidol or diamido-phenol and diphenal or diamido-oxydiphenyl contain two amido groups, and they are all formed by the reduction with a suitable reducing agent of the corresponding nitro-compounds.

Apparatus

The apparatus in which a reduction is carried out is a reducer, preferably built of cast iron, which need not be jacketed as all reductions are done in the presence of water, and therefore the mixture can be heated very simply by blowing in live steam. To protect the reducer against the action of the iron borings, which are stirred around, the inside of the kettle at the bottom is lined with cast-iron plates, which can easily be replaced and the presence of which therefore prolongs the life of the kettle. The agitator has the shape of a rake which almost touches the bottom and which moves the iron around sufficiently to prevent it from caking, while it also keeps the iron oxide suspended in the liquid. This oxide when once allowed to settle forms a cake which it is impossible to stir up, so that if the agitator is stopped for a sufficient length of time it is impossible to start it up again and the reducer has to be cleaned before the reduction can be finished. As many nitro- and amido-compounds are volatile with steam and also have poisonous properties, it is advisable to have the reducer covered, and where the volatility is great it is necessary to have the escaping vapors condensed and the condensate returned to the reducer.

Both the iron or zinc dust and the nitro-compound are put into the reducer gradually, the first because the strain on the agitator would be too large if all the iron or zinc were added at once, the second because it is then easier to keep the reaction under control. Reducers are built as large as 1600 gal., this large size being mostly used in the manufacture of aniline, of which 2000 lb. can be produced in one operation.

When the amido-compounds are volatile with steam, as in the case of aniline, toluidine and xylidine, they are separated from the iron oxide by distillation with steam, allowed to settle in separating tanks and separated from the water mechanically. To obtain them in a state of sufficient purity they are distilled in vacuum, and the product obtained in this way are practically c.p. if the hydrocarbon from which they are made has been pure. As toluol at present is required in large quantities for the explosive industry and commands a high price, it pays the manufacturer of these hydrocarbons to separate them as completely as possible, and their purity therefore leaves nothing to be desired. Commercial toluidine is a mixture of the ortho- and para-toluidine which can be separated before the reduction. Commercial xylidine, however, is a mixture of five different xylidines of which meta- and para-xylidine are of the most importance and present in the largest quantities. From this mixture the meta-xylidine can be obtained by separating it out as the acetate, the para-xylidine as the hydrochloride after the meta-xylidine has been removed.

In most other cases the amido-compounds are suf-

ficiently soluble in hot water to keep them in solution and separate them from the iron oxide by filtration, after the iron in solution has been precipitated with soda-ash. On cooling, the amido-compound will crystallize out and can be purified by recrystallization or distillation in vacuum, but some of the products of this class are so soluble that the solution has to be evaporated to dryness. This is especially true of the alpha-naphthylamine-sulfonic acids and most often, as we have seen, a mixture of two sulfonic acids is here obtained, for the separation of which we make use of the difference of solubility of their neutral or acid salts or the possibility of one being precipitated by adding salt to the solution while the other remains dissolved. The hydrazo-compounds obtained by reduction of a nitro-compound with zinc dust are neither volatile with steam nor soluble in water and have to be separated from the zinc oxide by dissolving this carefully in cold dilute hydrochloric acid, the zinc thereby being recovered as zinc chloride.

Outside the reducer and the vacuum still therefore no specially constructed machinery is required in this operation. The wooden and iron tanks which are used here are of very simple construction, while the apparatus for the separation of solids and liquids, such as filter presses are of the common types.

50 Church Street,
New York City.

The Chemical and Physical Properties of Foundry Irons

By J. E. Johnson, Jr.

Silicon

Next to carbon, this is the most important component of cast iron. It varies in ordinary iron from 0.2 up to 4.0 per cent. Above 4.0 per cent the iron passes into the field of "silvery" iron, and from thence to ferro-silicon. It is extremely difficult to make iron containing less than 0.2 per cent silicon in the coke furnace without having the sulphur run up to prohibitive limits. In the charcoal furnace iron can be produced with silicon as low as 0.10, or 0.15 in good white iron. The lowest I have ever seen it was 0.03, but this was in the spongy white iron of which I have spoken above.

Various investigations have been made as to the effect of the addition of silicon to steel. Sir Robert Hadfield conducted an extensive research on alloys of iron and silicon several years ago; this can be found in the *Journal of the Iron and Steel Institute*, 1889, Vol. II, page 222. The effect of silicon on steel (and therefore upon the matrix of gray iron also, in a general way), within the ordinary limits in which it occurs in foundry iron, was not particularly marked, but when the silicon rose above 3.5 per cent it diminished the ductility of the steel materially. I have already pointed out that the strength of the matrix of gray iron proper is far less important than the extent to which it is cut up by graphite, and for this reason within ordinary limits we do not need to consider very seriously the relatively slight effect of silicon upon the metal itself (that is the matrix), but its effect upon the carbon. This, as is well known, is to force the carbon out of the combined condition into the graphite, and thus action takes place not only above the melting point, but also down to relatively low temperatures.

It is best illustrated by the fact that ordinary coke iron of more than 1.0 per cent silicon will not show a white chill when cast against a chill block. Under any ordinary circumstances, this silicon is sufficient to force the graphitization of the carbon, in spite of the sudden

cooling. Below this percentage the chilling power of the iron is roughly inversely proportional to the amount of silicon present. The iron begins to show a chill as cast from the furnace a little below 1 per cent. At 0.75 silicon it will show ordinarily ¼ in. of white chill, at 0.5 silicon ½ in. chill, and at 0.25 silicon it will chill clear through a depth of 2 or 3 in., and will show much white in the pig, even when slowly cooled.

The completeness with which carbon is thrown out of the combined condition in unchilled iron is, in a rough way, similarly proportional to the silicon present. With 2 per cent silicon an ordinary coke pig iron will hardly show more than 0.25 per cent combined carbon, but the amount left in the combined condition will rise as silicon falls, until it may be as high as 1.0 per cent throughout the mass without the casting being chilled white on the surface, when the silicon goes down well below 1 per cent. These figures are subject to modification by considering half a dozen other factors besides silicon, and are correct only in a general way for average conditions. Definite figures are only given with great reluctance to avoid glittering generalities which sound well and mean so little.

Apart from this influence on the carbon, silicon, when it rises above 2 per cent, has the effect of hardening the matrix of the iron itself, so that an iron may be really harder to machine in consequence of having silicon added to it than it would have been with a somewhat smaller amount. There seems to be a certain probability, also, that the portion of the silicon burned out when the iron is melted in the cupola (about 0.25 per cent in ordinary practice) remains to some extent enmeshed in the iron, and gives rise to that bane of the foundryman's existence—"dirty spots"—in the casting. These, being in the form of silica or silicate of iron, are, of course, very hard, and vastly increase the difficulties of machining the casting which contains them, even though they may not be present in sufficient amount to cause the rejection of the piece.

The effect of silicon on the strength of the iron is, of course, very different in different portions of the silicon range. The amount which converts the iron from white to dense gray increases its strength by turning brittle and crystalline cementite into tough and homogeneous pearlite, even though the latter be somewhat cut up by graphite. But as the silicon content rises further and forces the combined carbon far below the pearlite ratio (say from 0.9 down to 0.2) it weakens the matrix and simultaneously increases the deposition of graphite and the size of its particles, interrupting the continuity of the structure, and in both these ways reducing the strength of the iron.

Sulphur

This is the most troublesome element in the metallurgy of iron. It is present in the coke with which irons are smelted, in amount from about 0.8 per cent up to 2 per cent. Probably in present practice it averages 1.10 per cent. Most of this is forced into the slag, but sulphur has an affinity for iron, and it is commercially impossible in coke practice to maintain the sulphur continuously much below 0.025 per cent in ordinary iron, and only down to that amount at excessive cost in coke and limestone over that required to hold it down to 0.04.

Charcoal is almost free from sulphur, and, therefore, irons with one-half this sulphur *may* be made with that fuel more easily than iron with 0.025 per cent can be made with coke. At the same time charcoal iron does not average below 0.018 and is seldom below 0.010. This matter has been subject to very wide misapprehension, which has been a hurt and not a help to charcoal iron. The low sulphur of charcoal iron has often been claimed as its principal virtue. With sulphur contents claimed to be "a trace" or "under 0.01 per cent," the latter statement is totally erroneous, since the sulphur in practically all charcoal iron is twice the amount claimed, and is little or no lower than that of a great deal of coke iron, while the increase in sulphur in remelting in the cupola is so much greater than that in good iron of either kind that a far greater improvement as regards this element can, in general, be produced in the final product by a little more care in buying and analyzing the coke for the cupola, rather than the pig iron. The real virtue of charcoal iron is to be found in a totally different direction, as I shall presently endeavor to point out. Its freedom from sulphur gives charcoal the advantage which it enjoys in producing iron of higher quality than can be produced with coke, except by treatment after it leaves the furnace, but the low sulphur of the iron itself is not the reason for this superiority.

Sulphur forms with iron a sulphide which has an extremely low melting point, and this sulphide dissolves in the iron itself in varying proportions in such a way that the sulphur exerts a threefold influence: First, it tends to hold the carbon in the combined condition; second, it tends to liquate out into segregated spots and, on account of its low melting temperature, sulphide of iron is extremely likely to bleed or run from the point which remains molten longest, and thereby cause a shrinkage cavity; third, it has an objectionable tendency to produce high shrinkage in the iron, with all the attendant difficulties of casting practice which accompany this condition.

Sulphur also has a very serious tendency to cause cracks in the iron, which is probably a result of the shrinkage. A white coke iron will often be high in sulphur, from 0.07 per cent up to 0.2 or 0.3 per cent in extreme cases. Such an iron, when quickly cooled with water, will crack up into little cubes like dice, each of whose faces is discolored almost black with a film of so-called "oxide color." White charcoal iron, on the other hand, of even lower silicon is tough and reasonably strong, and practically never shows this tendency to break up into small pieces with oxidized faces. This statement is important and will bear some emphasis. In making coke iron low in silicon "basic" we always expected to see these conditions if the furnace became somewhat cold. On the other hand, in charcoal practice extending over three years I never recollect to have seen a single case of this, although the charcoal furnace, with the quickness of its kind, was capable of getting into just as serious difficulties as the coke furnace ever did, and did so much more frequently. Conditions are so similar in other respects that it seems to me we must assume that this objectionable tendency to form cracks is due to the presence of sulphur. In the manufacture of chilled cast-iron car wheels the sulphur must be kept within certain limits at all hazards, as otherwise the wheels will crack under the thermal test.

For this poison in the iron we have as antidotes silicon and manganese. The silicon has no tendency to remove the sulphur, but, tending as it does to force the graphitization of the carbon, it resists the tendency of the sulphur to keep it in the combined condition. There is a rough-and-ready rule for the quantitative value of this effect, which is that 10 units of silicon are required to offset the effect of one of sulphur, so that, if the sulphur in the casting be raised 0.1 per cent, the silicon would require to be raised 1.0 per cent to offset the sulphur. It is almost certain, however, that, while the silicon prevents the action of the sulphur on carbon, it does not prevent its tendency to produce cracks and to increase shrinkage, with all its attendant evils.

The ordinary sulphur specifications for pig iron are 0.05 per cent for steel-making irons, and 0.04 or 0.035 per cent for foundry irons. For some special grades, for which a special price is paid, even lower limits are specified. When this iron is remelted in the cupola it always takes up some sulphur from the coke in the fuel bed; this amount varies from 0.02, in extra good practice, to 0.10 or even more, in bad practice, and, while I am not one of those who sneer at the foundrymen, it does seem that they are at times inconsistent, since many of them will make a violent protest if the sulphur in the pig is 0.01 per cent higher than the specifications call for, and will then buy a cheap coke which will raise it 0.05 per cent higher than would a really first-class coke.

I regard sulphur as the most objectionable element in cast iron with which we have to contend, and I believe the foundrymen are absolutely right in leaving no stone unturned to get the sulphur as low as possible in their castings, but sometimes it seems that they put the emphasis in the wrong place. In this connection, it may be said that the benefits in holding down the sulphur, which may be obtained by the use of lime and a little fluor spar to flux the ash and sulphur of the coke, are not as widely appreciated as they should be.

Phosphorus

The determination of the effect of phosphorus upon steel might almost be said to have been the first fragment of our modern knowledge of metallurgy. The readers are perhaps familiar with the story that after Sir Henry Bessemer's first successful production of steel on an experimental scale he licensed manufacturers to use the process, but when they came to do so the product was rotten and worthless. His process was condemned, and he himself was subjected to contumely for his claims. He set out to find by chemical analysis the reason for the failure, and discovered that it lay in the phosphorus content of the iron from which the steel was made, and that, by one of those curious tricks of fortune, he had bought for his experiments the only iron in England low enough in phosphorus to make good steel.

Once this was revealed, the ores which would produce iron of low enough phosphorus were located, and by using only these suitable iron for his process was obtained. With the exhaustion of the purer ores, the limit of the phosphorus set for Bessemer steel has gradually risen, until it is now about 0.09 per cent. Dozens of processes have been introduced for making good steel out of material containing more phosphorus than this without removing the latter, and it is said this may be done with some success so long as the carbon is low. When the carbon rises, however, such material always becomes brittle, uncertain, and unreliable. This has given phosphorus a bad name.

It has been assumed that because phosphorus was bad for steel it must necessarily be so for cast iron. Here again is found ignorance of that fundamental fact that a reduction of the strength of the matrix may be unimportant if a change in those conditions which affect its continuity is simultaneously made. Moreover, cast iron is a brittle material, and is not expected to be used in tension, or only under exceptional conditions, and there is no proof that phosphorus increases the brittleness of the metal until it reaches many times the limit permissible in steel. On the contrary, the Southern irons which carry in the neighborhood of 1.0 per cent phosphorus command a premium for foundry purposes.

The effect of phosphorus is probably due to the fact that it forms one or more definite compounds with iron, which have a low melting-point, and which dissolve in the iron and lower the melting-point of the whole mass.[1] This is different from the effect of sulphur, in which the tendency seems to be for the last freezing portions to segregate after the major portion of material has solidified. The fact that phosphorus contributes to the fluidity of iron is well recognized, and for many classes of castings which require to be made very thin the phosphorus is run up to 1.0 per cent or more. There is probably little doubt, however, that this content is high enough to affect the strength of the iron adversely. For general purposes, where strength is more and fluidity less important, phosphorus from 0.5 per cent to 0.75 per cent is to be preferred—the latter being only for lighter castings, the former for heavier and stronger castings.

(Since the above was written, I find that the experience of the automobile manufacturers has been that phosphorus must be kept below 0.3 per cent in their extremely complicated and difficult cylinder castings, as more than this causes a slight liquation from the heavier parts of the castings to the lighter ones and produces porosity at the former points. Castings are more difficult to make with this low phosphorus content and have to be poured considerably hotter than would otherwise be necessary, but this is the only method by which porosity can be avoided. For the ordinary run of thin foundry work, where these very severe conditions do not have to be met, higher phosphorus facilitates the work greatly.)

The effect of phosphorus up to about 0.4 per cent seems to be to increase the strength of iron. Remelts which I have made in crucibles proved this conclusively. Two remelts were made of the same iron, to one of which phosphorus was added, raising it from 0.13 to 0.40, the other not being changed in any way. This was done on two very different irons with the same result in both cases. The strength of the best bars was materially increased by the addition of the phosphorus, and so were the depth and character of the chill. These are both most desirable qualities for material such as car wheels, but the knowledge that somewhere below 1 per cent phosphorus begins to make the metal brittle and treacherous debars us from going beyond very moderate limits in this direction for castings in which strength and reliability are the prime consideration.

Oxygen

I come now to that portion of my subject in which I fear my readers' credulity may be strained to the breaking-point. I have referred already to the investigation made at Ashland to determine the reason for the difference in quality of charcoal iron and coke iron. The first results of this investigation were those already described on the effect of high carbon, but, while these explained why some iron was bad, they did not explain why the irons of normal carbon were stronger than the coke irons of similar analysis, and in some cases very much stronger.

I went into the investigation with a profound conviction that, next to sulphur, oxygen was the worst enemy of cast iron, but, after several months spent in a vain endeavor to confirm this hypothesis, I suddenly conceived the idea that the *presence* of oxygen, and not its absence, was that which made charcoal iron superior to coke iron. Two years of research were required before sufficient proofs of this hypothesis to justify publication were secured, but these proofs were finally obtained and the results were published in a paper before the American Institute of Mining Engineers, under the title "The Effect on the Strength of Cast Iron Exerted by Oxygen,

[1] J. E. Stead, "Iron and Phosphorus," *Journal I. and S. Inst.*, 1900, II.

Nitrogen, and Some Other Elements." The results of this investigation were at first violently combated by some scientific metallurgists, but are now being more and more accepted.

We found, first of all, that certain irons made when the furnace had been in trouble and working cold were exceedingly strong (sometimes, though not often, almost twice as strong as irons of practically identical analysis made at other times). We found that, after being remelted in crucibles, the strong ones retained and even increased their advantage in strength over the weak ones. We found, too, after months of trial, how to make oxygen determinations in cast iron; that the strong irons contained oxygen; that the weak irons contained little or none, and that those of normal moderate strength contained an intermediate amount.

By a curious coincidence, a very extensive thermal investigation of the action of charcoal and coke blast furnaces was being simultaneously undertaken for the purpose of bettering the fuel economy if possible. This investigation revealed the fact that furnaces which produce the strong irons are those which run with a deficiency of heat in their hearths and so tend to an incomplete deoxidation of the ore—that is, tend to leave a small amount of oxygen in the iron, while those furnaces which produce the weakest irons are those which generate the greatest excess of heat in the hearth and produce the metal at a temperature the highest of any above its melting-point, ending with the electric furnace, which develops practically all its heat in the hearth, and produces its iron at an excessively high temperature, this iron being the weakest of any variety of cast iron made. (See Figs. 10 and 11. Note the shape of the graphite and how it cuts the structure of the iron completely to pieces.)

Photomicrographs of different irons showed the reason for the increase in strength in the strong irons, since the graphite in these irons is relatively round and nodular compared with the graphite in the weak irons, which is thin and of tremendous extent, and cuts the iron like crooked knife strokes in all directions.

In Figs. 12 to 27 are shown strong irons and also weak irons of similar analysis, both before and after remelting. These figures are reproduced from the paper just mentioned. Figs. 29 to 33 show in particular an extremely nodular condition of the graphite, and indicate more plainly than can any words how much stronger these irons must necessarily be than those of similar composition containing thin, flaky graphite.

The experiments described in the same paper, and briefly referred to here, are only a selection from the multitude of experiments, all pointing to the same conclusion, carried on throughout the investigation mentioned.

It seems that the effect of the oxygen is fivefold:

First, it tends to throw the graphite into the nodular condition. The theory as to the action by which this takes place has not yet been fully confirmed by scientific investigation, but coordinates so many facts that I am satisfied it is correct, and feel justified in pointing it out here. Observation has convinced me that the irons which contain oxygen have a higher melting-point than those which do not contain it. When approaching the freezing-point, they do not freeze suddenly, as water turns to ice, but pass through a slushy or pasty stage, very different from that of hot-made coke iron. When graphitization begins in the latter it is still liquid, and the graphite forms from the liquid absolutely without any stress whatever upon it, and is therefore free to assume whatever shape it chooses, irrespective of how great the volume and surface of that shape may be.

But these oxygenated irons solidify at a higher temperature, at which little or no graphitization has yet taken place, and by the time they have cooled to the temperature of graphite evolution the iron matrix has become sufficiently solid to be the dominating element in the combination. The graphite forms, but forms only against the heavy pressure exerted by the preformed solid of the metal. In consequence, the graphite must form so as to take up minimum volume and surface. In other words, it must take this spherical form in which it is seen in Figs. 26 to 31.

A confirmation of this theory is that good charcoal

FIG. 10—UNETCHED. (MAGNIFIED 100 DIAMETERS.) ELECTRIC FURNACE IRON. NOTE EXTENT AND INTERSECTIONS OF GRAPHITE. STRENGTH OF THIS IRON VERY LOW, TEMPERATURE OF MANUFACTURE VERY HIGH. OXYGEN CONTENT ZERO

FIG. 11—ETCHED... (MAGNIFIED 100 DIAMETERS.) SAME AS FIG. 10. NOTE COMPLETE ABSENCE OF PEARLITE AND JOINTS IN FERRITE. THESE NEVER OCCUR IN OXYGEN-BEARING IRONS
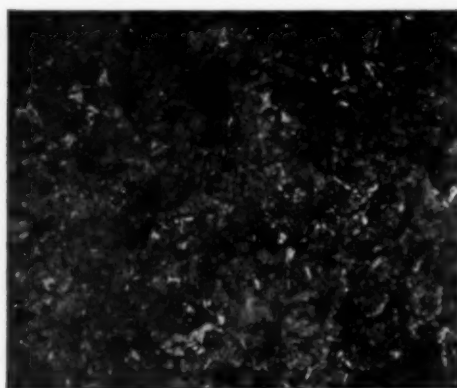
FIG. 12—UNETCHED

FIG. 13—ETCHED

(MAGNIFIED 100 DIAMETERS.)   GOOD IRON.   SILICON, 1.90; OXYGEN, 0.27 PER CENT
BREAKING STRENGTH, 1.25-IN. BAR, 3000 POUNDS, 3350 POUNDS

irons are noted for their low shrinkage, whereas bad ones are noted for their high shrinkage. This is, I believe, because when the graphite forms in the liquid, as it does in the oxygen-free irons, the iron then solidifies around it and after solidifying shrinks continuously until cold. But when the metal solidifies *previous* to the formation of graphite, the latter forms against the resistance of the metal, which results in an increase of volume of the latter after solidification, and this expansion is deducted from the total shrinkage in the final result.

This theory is not absolutely demonstrated as yet, but it is certainly in accordance with all the facts and is well worthy of an investigation, which I hope will be undertaken by some of the scientific metallurgists within a year or two so as to confirm or refute it.

Whatever may be the facts in regard to shrinkage, the increase in strength of irons which contain oxygen over those which do not contain it is a matter not open for discussion, nor is the shape into which it throws the graphite.

Second, the oxygen seems to exert another influence by changing the form of the crystallization of high carbon irons from that of the eutectic, previously shown in Fig. 3, to that of the mesh-work structure, shown in Figs. 5 and 6. By this means it increases the strength of the matrix, as well as diminishes the detrimental action due to the graphite.

Third, oxygen seems to act as a brake on the separation of the carbon and to prevent the hard and strong needles of cementite which exist above the last transformation point from breaking down into graphite

and ferrite, of which only the latter has any strength at all, and that much less than any other iron-carbon compound.

This action is clearly shown in Fig. 28, a photomicrograph of a coke iron of excellent reputation, exhibiting a number of long, slender plates of graphite with similarly s h a p e d bodies of ferrite on one or both sides of them. These jointly constitute the remains of crystals of cementite by whose breaking down they were formed. The structure is obviously a weak one, not only on account of its shape, but because the graphite and ferrite are so much weaker than the original cementite.

This structure is never seen in irons containing any important amount of oxygen, for the reason that oxygen seems to prevent the breaking down of iron-carbon compounds to a point very far below the pearlite ratios of 0.9 per cent, such irons of moderate silicon ranging from 0.6 to 1.0 per cent combined carbon and seldom containing any visible ferrite.

I do not pretend to be able to explain this latter fact, but it is a fact in my own experience, nevertheless. The carbon range given, 0.6 per cent to 0.9 per cent, is that embracing the strongest steels, and this fact is undoubtedly of considerable influence in making these irons so strong.

Fourth, oxygen has an effect on a matrix itself, considered as a steel. This, as is known by the best-informed steel metallurgists, is that it strengthens the steel, but reduces its elongation and increases its brittleness. Undoubtedly the oxygen exercises the same influence on the matrix of the iron, but the results as regards brittleness are the opposite of what they are in steel, because nothing promotes brittleness so much as gashes in the material, such as are caused by flat flakes of graphite, and suppressing these not only increases the strength, but also largely eliminates what might be called incipient cracks, from which breakage might start; and this effect, therefore, reduces the brittleness of the metal far more than the slight effect on the matrix increases it. As a matter of fact, soft irons containing oxygen have not only greater strength, but also a degree of toughness amazing to those used to only ordinary cast iron; they seem almost to bend before breaking.

Fifth, oxygen exercises also a very important influence on the chilling power of the iron, due to its retardant action in the separation of the carbon, and it was undoubtedly for this reason that the use of high-grade charcoal iron was formerly almost universal for car wheels and remains accepted practice to-day for the production of those chilled castings which demand high quality and bring a high price. It seems to be a fact that
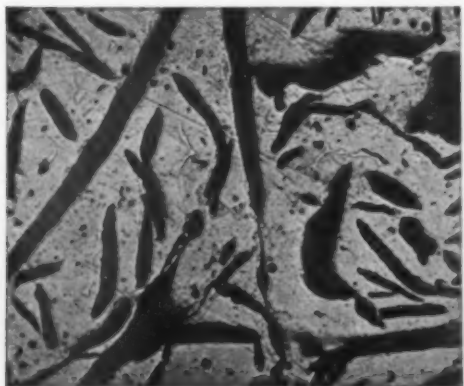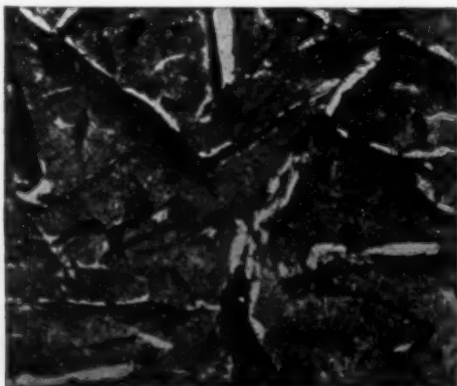

FIG. 14—UNETCHED

FIG. 15—ETCHED

(MAGNIFIED 100 DIAMETERS.)   POOR IRON.   SILICON, 1.88; OXYGEN, 0.009 PER CENT.
BREAKING STRENGTH, 1.25-IN. BAR, 2500 POUNDS, 2900 POUNDS

the presence of oxygen not only increases the chilling power of the iron, but also increases its sensitiveness to chilling influences. An iron containing oxygen, if cast in sand, will retain somewhat more combined carbon than a similar iron not containing oxygen cast under the same conditions, and if the irons are cast against a chilling surface the one containing oxygen will begin to show a white chill at a higher silicon than the other, and will continue to show greater chill for the same silicon as the latter element decreases all the way to the lowest limits.

FIG. 16—UNETCHED

(MAGNIFIED 100 DIAMETERS.) REMELT. SILICON, 1.90 PER CENT. BREAKING STRENGTH, 1.25-IN. BAR, 3150 POUNDS, 3200 POUNDS

Moreover, the character of the two chills is quite different. The chill of the oxygen-free iron is made up of needle-shaped crystals, or rather crystals shaped like long, slender pyramids, with their axes perpendicular to the chilling surface, their sides brilliantly polished, and making sharp angles with each other, so that the crystalline mass has but little strength in any direction parallel to the chilling surface. The chill of the oxygenated iron, on the other hand, shows crystallization normal to the surface. But these crystals, instead of being highly polished, have rough faces, so that they interlock with one another. The chill shades well into the gray at the base, the mottled area containing little stars of graphite in the field of white.

It is impossible to describe in detail, or even to show by photomicrographs, comparative chill structures, but those whose business is the manufacture of high-grade chilled castings have never ceased to use charcoal irons, even though they cost two to three times as much as coke iron of the same nominal analysis, for the reason that, with this iron, they have found by experience they can produce castings of a quality to justify their customers in paying the difference in price.

That the difference between charcoal iron and coke is in the carbon and oxygen I have described already, and in those two elements alone we have proved (so far as anything is capable of any absolute proof in so complicated a subject) by analyzing not only for all the common elements, but also the rarer ones and for gases such as nitrogen and hydrogen. Hydrogen we found to be absent, but nitrogen we found to be present in varying quantities, but no variation of the quality of the iron attributable to its variation could be observed, and, while we added nitrogen to the remelts by introducing nitrogenous substances, the differences produced even by considerable additions of nitrogen were unimportant.

Here, then, we find, as has so often been found before, that these curious, one might almost say mysterious, variations of quality arise not from variations of one element, but
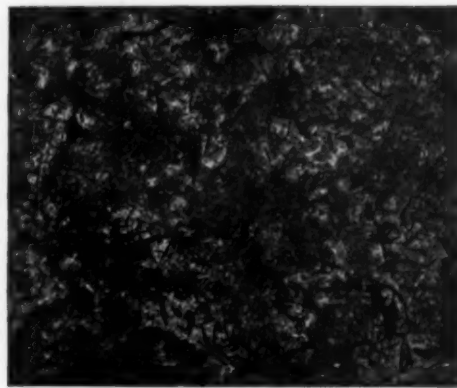
from simultaneous variations of two. We have variations of carbon from well above to well below the eutectic ratio, with the resulting low quality in the first case; and we have, with this, variations in the oxygen whose presence results in greatly improved quality, whether with high or with low carbon. Considering the complexities of the operation of the blast furnace, the little that we have known until recently about its thermal equilibrium and the variations in the latter produced by different conditions of working, and the effect of these variations on the carbon and oxygen contents of the iron produced, it is not surprising that the variations in the quality of charcoal iron, as controlled by variations in the quality of charcoal iron, as controlled by variations of furnace practice, were so difficult of understanding as to seem positively mysterious.

The analysis of the thermal equilibrium of furnaces, to which I have before alluded, shows that those furnaces which produce good iron run with a relative deficiency of heat in the hearth, while those which produce bad iron run with an excess of heat in the hearth.

Observation both by eye and with the pyrometer shows that irons made under the latter condition are much higher in temperature as they come from the furnace than those made under the former, and this leads to two results—elimination of oxygen (which appears to be a function of temperature more than anything else) and super-carbonization of the iron, because while we know but little concerning the conditions which control the carbonization of iron, we do know that the degree of saturation possible increases with the temperature.
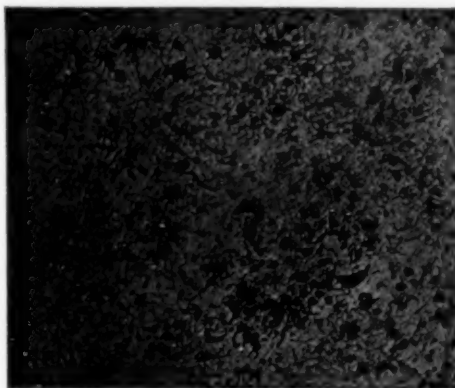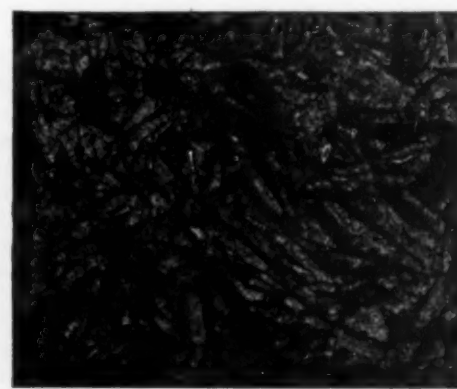

FIG. 18—UNETCHED

(MAGNIFIED 100 DIAMETERS.) REMELT. SILICON, 1.88 PER CENT. BREAKING STRENGTH, 1.25-IN. BAR, 2600 POUNDS, 2700 POUNDS

We find, therefore, that those furnaces which work with excess of heat in the hearth tend to super-carbonization and to complete deoxidation, thereby lowering the quality of the iron, both by giving the weak eutectic structure to the matrix and by cutting it to pieces with large flakes of graphite.

In the case of cold blast charcoal iron, we have probably a modified condition of the enormous volume of carbon in the hearth tending to carbonize this iron more highly than normal, in spite of its low hearth temperature. We have here, then, a condition tending toward fairly high carbon, but also a condition of low temperature favoring high oxygen, and these are characteristic of iron produced by this process. The carbons are not excessive, ranging around 4 per cent in good, cold blast iron, while the oxygen is the highest in any standard variety of iron produced, ranging in such samples as we have analyzed from about 0.05 to 0.07.

These two facts are largely responsible for giving this iron its desirable characteristics, because the presence of oxygen seems to prevent absolutely the excessive graphitization of carbon, even when the carbon contents are high. This seems to be in line with the fact above mentioned, that oxygen exerts a general tendency in the direction of preventing the breaking down of the combined carbon into the graphite form.

Thus, with cold blast iron, we can secure the benefit of a large percentage of cementite in our chilled castings, without the danger of having this break down into graphite, as happens with carbon irons free from oxygen. We are able, therefore, to obtain extremely hard chill along with the extreme closeness of grain and the accompanying physical strength in the gray portion which oxygen brings.

Manganese

Manganese has been praised by many as a panacea for almost all the ills to which the foundry trade is liable, whether from too soft or too hard castings. On the other hand, it has been unhesitatingly condemned by many other able foundrymen as the basis of most foundry errors, particularly with chilled castings.
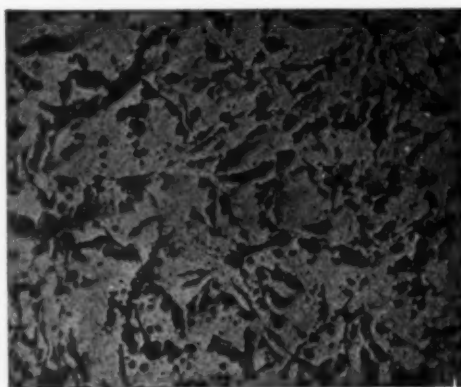
FIG. 20—UNETCHED

FIG. 21—ETCHED

FIG. 22—UNETCHED

MAGNIFIED 100 DIAMETERS. GOOD IRON. SILICON, 0.70; OXYGEN, 0.065 PER CENT. BREAKING STRENGTH, 1.25-IN. BAR, 3500 POUNDS, 4200 POUNDS
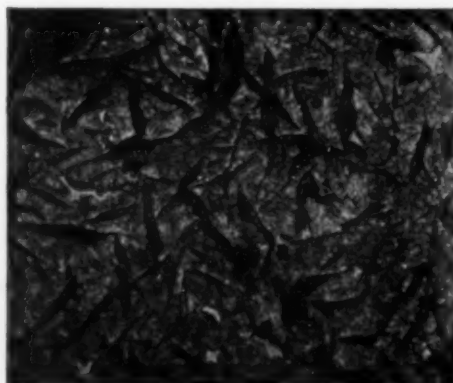
FIG. 23—ETCHED
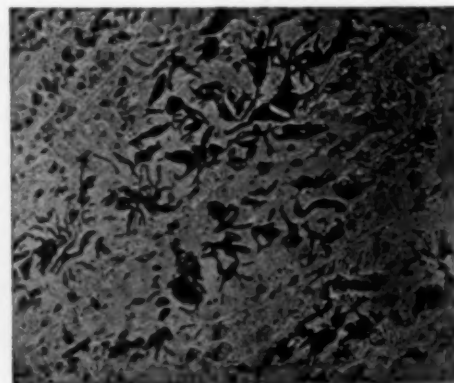
FIG. 24—UNETCHED

(MAGNIFIED 100 DIAMETERS.) POOR IRON. SILICON, 0.72; OXYGEN, 0.009 PER CENT. BREAKING STRENGTH, 1.25-IN. BAR, 2500 POUNDS, 2500 POUNDS

The effect of manganese on steel has been exhaustively investigated (see "Manganese Steel," R. A. Hadfield, *Journal Iron and Steel Institute*, 1888, Vol. II), but, within the limits in which it is used in foundry practice, it is probable that we can largely ignore this effect on the matrix of the iron, on account of its more important collateral actions. These are important and are two or three in number, and it is certain that the effect of manganese, like that of silicon, undergoes a reversal after it exceeds a certain amount. Manganese has a greater affinity for sulphur than has iron. It is, in fact, a much more active element chemically than iron in all particulars. As a result, it takes the sulphur away from the iron and forms with it manganese sulphide. It is a general law of metallurgy that a metal will dissolve compounds of itself, but not compounds of another metal with anything like the same facility. In consequence of this law, the manganese sulphide separates out from the iron and rises to the surface. It may be seen doing this in the ladle under certain conditions, and even where it does not separate out completely, manganese sulphide, not being dissolved by iron, is much less harmful than iron sulphide, which is dissolved by it with the consequences above described.

The first effect of the addition of manganese is,

therefore, to remove a part of the sulphur. The action is not quantitative, and several times the amount of manganese sufficient to form manganese sulphide with all the sulphur present must be added to obtain the removal of much of this latter. The manganese which does not combine with the sulphur combines with the iron, when molten, in the condition of a double carbide.

Manganese, having a higher affinity for carbon than iron, causes an increased absorption of carbon by the metal in the blast furnace, even up to 6 or 7 per cent in ferro-manganese and up to 4 or 5 per cent, in spiegeleisen containing from 18 to 22 per cent of manganese.

The effect of the manganese itself, after it passes 1 or 2 per cent, is to harden the iron, by holding more of the carbon in the combined condition. This increases

knife-like crystals with extremely smooth faces, so that the end of a broken pig of spiegel often shows crystals sticking out almost like knife blades, and the whole surface is made up of the faces of intersecting crystals with but little cohesion with one another.

It is probably this tendency which gives car wheels, which obtain their chill by the use of manganese, their tendency to "shell out," that is to say, under extra stress, a group of these crystals lose their cohesion with one another, loosen and finally fall out, producing what car-wheel men call a "shell-out." Moreover, the manganese chill is much softer than a straight iron chill, and breaks down under wear.

The activity of manganese as a deoxidizer, as well as a desulphurizer, is well known, and when manganese is added to metal high in oxygen some of this latter oxygen is promptly scoured out; the chilling power and strength of the metal are thereby reduced. On the other hand, if still more manganese be added, when $1\frac{1}{2}$ to 2 per cent is reached, the strength of the iron and its chilling power increase, on account of the direct action of the manganese in throwing the carbon into the combined condition, but in the form of flat plates, as I have just explained.

FIG. 25—ETCHED

(MAGNIFIED 100 DIAMETERS.) REMELT.
STRENGTH, 1.25-IN. BAR, 4150 POUNDS

FIG. 26—UNETCHED

SILICON, 0.70 PER CENT. BREAKING

FIG. 27—ETCHED

(MAGNIFIED 100 DIAMETERS.) REMELT.
SILICON, 0.72 PER CENT. BREAKING
STRENGTH, 1.25-IN. BAR, 2750
POUNDS

the strength of the matrix in ordinary gray irons and also limits the formation of graphite. The result of these actions is that manganese strengthens the iron in addition to increasing its chilling power, and it is used for this latter purpose to make chilling irons harder, as well as to make soft irons softer.

It is obvious, from what has been said, that these actions are the results of two different sets of effects, one of which predominates in the one portion of the manganese range and the other in the other. The objection to the use of manganese for producing chill is that iron containing much of it crystallizes into large,

FIG. 28—ETCHED

(MAGNIFIED 70 DIAMETERS.) COKE IRON.
NOTE THE LONG, SLENDER BODIES OF
GRAPHITE AND FERRITE SIDE BY SIDE
FORMED BY THE BREAKING DOWN
OF CEMENTITE CRYSTALS

This conflicting tendency, in conjunction with its effect in removing sulphur and the powerful effect of that element on the quality of the castings, makes it perfectly evident that the rôle of manganese is an extremely complicated one, but, on account of this powerful deoxidizing influence, it is my judgment that it should be kept low in all castings where the highest qualities, particularly strength, closeness of grain, and chilling power, are desired, because while these qualities *of a kind* can be obtained by the use of manganese in considerable quantity, the fundamental structure of the iron produced is inherently inferior to the structure produced by the presence of oxygen, and it is a matter of established practice that, in the production of chilled castings, the desired result cannot be obtained by the addition of ferro-manganese alone, as at one time was thought to be the case.

Some manganese, perhaps up to 0.5 or 0.6 per cent, is desirable in cupola melted iron, to hold the sulphur in check, and it may be useful for other purposes in special cases, but for the best castings manganese should generally be kept within very moderate limits. Some of the manufacturers of chilled rolls will not tolerate it above 0.30 per cent.

FIG. 29—UNETCHED. (MAGNIFIED 100 DIAMETERS.) "SPECIAL" CHARCOAL IRON, SHOWING FINELY DI-VIDED AND ALMOST COMPLETELY NODULAR GRAPHITE

The Effects of Time

Before discussing the effect of other elements on the iron-carbon alloys, it might be well to discuss the effects of time. The iron-carbon diagram shows only equilibrium conditions, and the time required for the attainment of some of the equilibriæ shown by the iron-carbon diagram is extremely short, while for others it is very long. Hence the diagram cannot tell us what will happen in any case unless the time factor is considered.
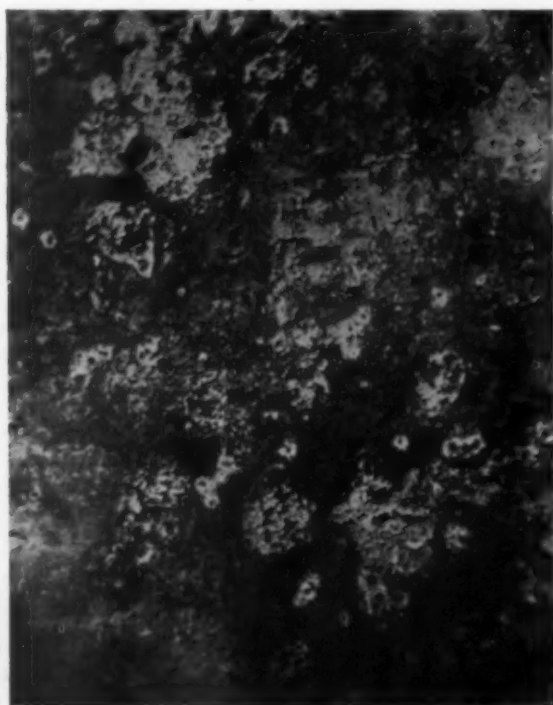
The most important effect of time (that is, of the rate of cooling) is its influence on the graphitization of the carbon after solidification. The evolution of graphite during cooling through the molten condition seems to occur only with hypereutectic irons, and this appears to be a function of time, because irons which throw off graphite into the air as they run from the furnace can only be converted into good castings from this initial heat by pouring hot and just as quickly as possible. If poured slowly, the graphite will accumulate at the top of the mold so as to make the whole top of the casting worthless—it will be "worm eaten" at the best, and at the worst may contain great cavities filled with loose graphite flakes of large size. Whether hot pouring simply causes the metal to set more quickly and thus prevent the rising of the hypereutectic graphite, or whether the formation of the graphite is actually prevented, I have never determined, but it is probable that both effects play a part.

In regard to the graphitization after solidification, our knowledge is more definite. In this case all the carbon not thrown out as hypereutectic graphite is combined at solidification, and, if the cooling be rapid from that point, the iron will remain perfectly white. But, if the casting be made to cool slowly, it will not only graphitize, but the graphite may form into very large flakes. The best illustration of this is to be found in the salamander taken from the hearth of the furnace after blowing out. This contains huge flakes of graphite an inch or two in extent, and the intersections of the flakes cut the iron into irregular solids quite without cohesion, so that a large lump of salamander can frequently be broken apart with the fingers into pieces of small size, each consisting solely of iron and graphite. Fig. 34 shows a microphotograph of such a piece, and shows why this must be so. The iron in this case has remained just below the melting-point for several years.

From this point of view, the action of chilling becomes extremely simple. We merely shorten the time

FIG. 30—ETCHED. (MAGNIFIED 100 DIAMETERS.) SAME AS FIG. 29
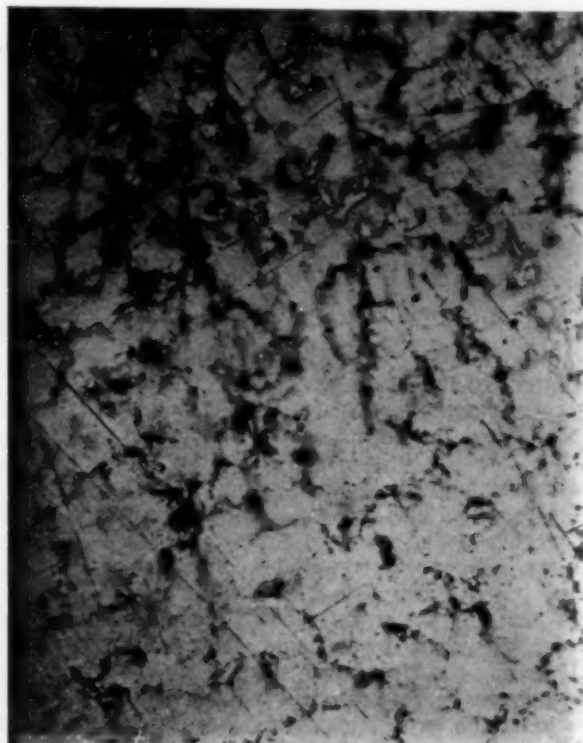
FIG. 31—UNETCHED. (MAGNIFIED 100 DIAMETERS.) COKE IRON-OXYGEN. SAME AS FIG. 6. (KINDNESS OF PROFESSOR CAMPBELL)

of cooling through the range in which graphitization could take place so as to prevent or diminish this action and leave the carbon in the combined condition. T h e surface next the "chiller" is the whitest and hardest, because its heat is removed instantly, while the metal back of it has to be conducted through the chilled surface and also through the warmed face of the chiller into the cold metal behind it. This is obviously a much slower operation, and, as a result, more graphitization can occur in the metal behind the chilling face.

FIG. 32—UNETCHED. (MAGNIFIED 100 DIAMETERS.) OXYGENATED COKE IRON, SHOWING NODULAR CONDITION OF GRAPHITE

FIG. 33—ETCHED. (MAGNIFIED 100 DIAMETERS.) SAME AS FIG. 30

In the same way, if the chiller be too light in proportion to the body of the metal to be chilled, a very insufficient chill will result, because the thermal capacity of the chiller is only sufficient to absorb the heat from a thin zone of the molten metal, and this is promptly heated up again by the larger body of molten metal behind, which "draws" the chill already formed, exactly as a blacksmith draws the temper of the quenched edge of a tool.

Silicon and time, then, are seen to be the principal factors making for graphitization, while oxygen, sulphur, and manganese are the principal ones resisting it. Of these three, manganese is hostile to the other two, and, if present in sufficient quantity, destroys their effect, while its own effect does not alone give a chill

of the character desired. Sulphur gives a hard chill, but an essentially brittle and unreliable one, accompanied by high shrinkage and weak structure back of the chill. Oxygen gives a tough, hard chill, low shrinkage, and the strongest and best structure back of the chill.

(To be Concluded)

The **Hydraulic Press Manufacturing Co.,** Mount Gilead, Ohio, has received an order for 70 hydraulic hot plate presses to be used for vulcanizing purposes. They will be operated from hydraulic pump and accumulator systems already installed and are all of one design with a pressure capacity of 115 tons each.

Some Uses of Magnesite.—Magnesite is used for the manufacture of epsom salts, carbon dioxide for mineral waters, etc., patent floorings for buildings, cupels for assaying, cement for lining tube mills used on the Rand, South Africa, basic fire-bricks, body for certain paints and mixed with asbestos for making roofing materials, tiles, etc. (South African Mining Journal, Sept. 9, 1916, p. 31.)

British Zinc Smelting Industry. The British Government has agreed to purchase 100,000 tons of zinc concentrates per annum for the period of the war and ten years thereafter from Australia. This contract will assure Australia of a steady outlet for ore and at the same time opens up a much needed source for Great Britain. The British Government has also agreed to lend the Australian Commonwealth $2,500,-000 for the erection of smelting plants and to take yearly 45,000 tons of the spelter produced. In the past Great Britain consumed approximately 195,000 tons of spelter per annum. With the 100,000 of zinc concentrates, which furnish in the neighborhood of 30,000 tons of spelter and the 45,000 tons of spelter furnished in the near future by Australian smelters, England will produce, with its own 60,000 tons, about 135,000 tons of spelter. It is seen, therefore, that approximately 60,000 tons of spelter will still have to be sought elsewhere to furnish the required tonnage of spelter for Great Britain.

Zinc in Japan. In a short time the new zinc plant built at Hikoshima, in the Shimoneski Straits, by the Suzuki Shoten of Kobe will be completed. Operations were commenced in April, 1916, and when the plant is completed it will employ about 4,000 people.

FIG. 34—ETCHED. (MAGNIFIED 100 DIAMETERS.) SALAMANDER. THE HEAVY BANDS OF GRAPHITE HAVE COMPLETELY DESTROYED THE CONTINUITY OF THE STRUCTURE

Synopsis of Recent Metallurgical and Chemical Literature

Conversion Tables

Conversion Tables for the Valuation of Ores, Minerals and Metals is the title of an article in the September, 1916, number of *The Mining Magazine*, pp. 152 to 155. It is one of the unfortunate conditions faced by those concerned with the international trade in metals, that the standards of weights and measures, as well as the monetary systems in various countries, are not the same. Anything, therefore, which will facilitate the calculations involved in the market manipulations of metals, etc., is of paramount interest to the metallurgical industries. The first table illustrates the effect on exchange, when the market prices per pound in cents change and have to be converted to pounds sterling per ton for the English market. Table II is a conversion table for converting cents or pence per pound into pounds sterling per ton, and Table III converts values in pence or cents per unit, or vice versa, to price in pounds sterling per ton, at various percentages. For the tables the reader is referred to the original article.

Flotation

Pine Oil for Flotation Purposes.—An article published in the October, 1916, *Bulletin* of the Canadian Mining Institute treats of experiments conducted by T. R. JONES at the Buffalo Mine, Cobalt, Canada, to determine the feasibility of producing a pine oil suitable for flotation from Canadian pine trees. The materials tried were spruce wood, spruce bark, jackpine stumps, white cedar needles, and Norway pine stumps. These materials were subjected to dry distillation and the products investigated. The conclusions drawn from the tests were: Norway pine stumps were best suited for producing oils; the distillation need not be carried above 400 deg. C., as further heating produces heavy tar; the use of superheated steam aided in the starting of the distillation, but did not prevent the cracking of the oils, and finally in redistilling the oils the pressure maintained on the vapor has a marked effect on the final products; a sufficiently low pressure breaking up all the pitchy products into a sort of paraffine.

Gold and Silver

Mining and Milling Practice at Santa Gertrudis.—A paper under this title was published in the August *Bulletin* of the American Institute of Mining Engineers, pp. 1295 to 1332, written by HUGH ROSE. Fig. 1 gives a complete flow sheet of the mill, the details of which are clearly indicated. The main feature of construction is the sacrifice of compactness in order to obtain a gravity flow, the slope of the mill site being 17 deg. The capacity of the plant is 1100 tons per day, and the milling business is conducted on a custom basis. The total cost of the plant was $792 per ton daily capacity.

A great deal of experimental work has been conducted on aluminium dust precipitation, electrolytic regeneration of cyanide, electrolytic refining of precipitates and flotation concentration. It was found that aluminium dust precipitates yield a bullion 975 fine, and that the aluminium dust required was about one-third that of the zinc dust. The slight increased cost per ton of ore of aluminium dust is more than offset by the decreased consumption of cyanide, the net saving being $0.15 per ton of ore.

In the electrolytic regeneration of the cyanide the main difficulty was to find an anode of high conductivity that would not dissolve or disintegrate. The anode finally decided on was one composed of lead containing 6 to 9 per cent of antimony. The conclusions drawn

from the work were: The solution to be treated electrolytically must be barren of gold and silver to avoid precipitation; the regeneration of the cyanide takes place at the cathode, with a decomposition at the anode. The latter may be overcome by maintaining a high protective alkalinity at the anode; to maintain an alkaline anolyte a porous partition such as canvas is used, the circulation of the anolyte and the catholyte being accomplished individually; the voltage drop per cell, at a current density of 15 amperes per sq. ft. of anode surface, treating barren solution containing 0.5 per cent total KCN and 0.115 per cent CaO, with canvas diaphragm and electrodes 1½ in. apart, is 6 volts at 70 deg. Fahr. Under these conditions the solution flow should be at least 0.25 gal. per sq. ft. of anode surface; the cathode deposit analyzed 71 per cent zinc, with copper, iron, arsenic and organic matter as impurities; the reaction taking place is $Na_2Zn(CN) + Ca(OH)_2 + current = 2NaCN + Ca(CN)_2 + Zn + H_2O + O$; the reduction of the cost was $0.12 per ton of ore. The equipment cost more than for aluminium dust precipitation.

FIG. 1—MILL FLOW SHEET

The electrolytic refining of the precipitates was only in the preliminary state, and no conclusions are given. The main difficulties to be overcome are resistance of the precipitate to the current purification of the electrolyte, high acid consumption due to impurities and refining and melting of the gold slime.

The preliminary experiments on flotation gave the following results: One-third pine oil or wood creosote and two-thirds Mexican gas oil are the most satisfactory oils as far as the oil tests have been made; no particular benefit is derived from the addition of acid; a slight alkalinity not exceeding 0.03 lb. lime per ton solution is satisfactory; heating the solution shows no material improvement; the flotation tailings are readily cyanided; the raw flotation concentrate cyanides as readily as gravity concentrate; with laboratory machines a recovery of 65 to 70 per cent can be made by flotation, the ratio of concentration being between 80 and 90 to 1. A 100-ton testing plant is being constructed, and good results are anticipated.

Copper, Lead and Zinc

Comparison of Electrolytic and Lake Copper.—C. H. MATHEWSON and E. M. THALHEIMER cover this topic in an article published in the July *Bulletin* of the American Institute of Mining Engineers. Samples of electrolytic copper and two typical samples of lake copper were tested with respect to strength and ductility, both when cold worked and after annealing.

The two samples of lake copper were one known as Mohawk and carrying 0.096 per cent arsenic, and the other known as Copper Range Copper, and carrying 0.296 arsenic. Tables and curves are given summarizing the work. The conclusions drawn are: During the early stages of rolling, Copper Range Copper decreases more rapidly in ductility than electrolytic copper, but both products increase in strength about equally. During the later stages of rolling both products decrease about equally in ductility, but the Copper Range Copper increases more rapidly in strength than does the electrolytic copper. The Mohawk brand lies between the two others. The differences in ductility, as measured by reduction of area, are confined to the earlier stages of rolling.

Generally speaking, the Copper Range product takes a harder temper on rolling than the electrolytic copper, but does not finally become less ductile. They both seem to stand the same amount of rolling, but the electrolytic copper rolls slightly easier.

If it is desired to finish a previously annealed product with a limited amount of ductility, but increased strength, by rolling through several gages, Copper Range metal is preferable, as the strength is increased considerably without sacrificing the ductility.

The results obtained from the tests after annealing under oxidizing conditions show that the differences in strength throughout the range of 400 deg. C. to 1000 deg. C. were slight. The Copper Range metal always showed the highest reduction of area and elongation, then followed the Mohawk, and lastly the electrolytic copper. Near the temperature of deterioration, beginning at about 700 deg. C., the relative ductilities of the Copper Range and the electrolytic copper are such that the former can stand an additional 100 deg. of overheating before dropping to the ductility value of the latter.

Tests after annealing under reducing conditions show that in general Copper Range material is slightly less susceptible to the evil effects of reducing annealing than either of the other two varieties. None of these coppers will retain its ductility after annealing above 40 minutes in a strong reducing atmosphere at 600 deg. C.
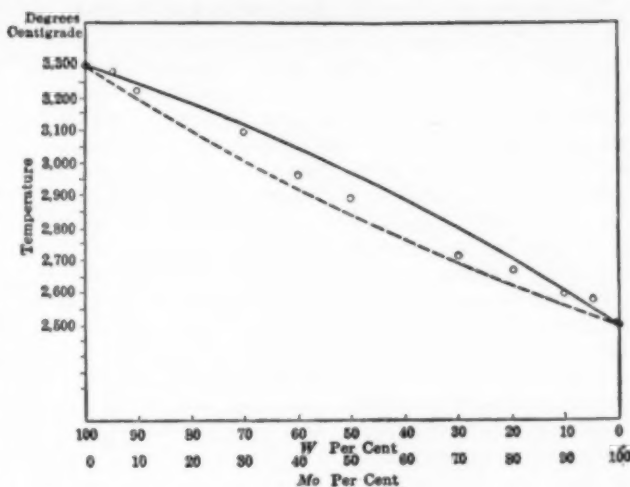

FIG. 2—EQUILIBRIUM DIAGRAM OF TUNGSTEN AND MOLYBDENUM

A large number of microscopic photographs with the necessary explanation terminates this article.

Tungsten and Molybdenum

The Tungsten-Molybdenum Equilibrium Diagram.—ZAY JEFFRIES, in the July *Bulletin* of the American Institute of Mining Engineers, treats the above-mentioned subject and also the system of crystallization of tungsten and molybdenum. The melting points were determined by the fusion wattage method. The apparatus and procedure used are fully described with a discussion on the accuracy involved. The diagram obtained by Jeffries is reproduced in Fig. 2, and shows that the alloys form an unbroken series of solid solutions. Microscopical determinations prove undoubtedly that both molybdenum and tungsten crystallize in the isometric system. The article contains several interesting microphotographs.

Allotropy

Allotropy of Silver.—In a paper presented at the recent London meeting of the Institute of Metals, Dr. W. D. HELDERMAN of Utrecht University, Holland, gave the results of investigations on the allotropy of silver. The author was awarded a Carnegie research fellowship to carry on investigations on the metastability of metals, and had originally intended to experiment with iron. As silver could be obtained in a very pure state and the problem was not so complicated it was decided to substitute this for the iron.

The author reviewed the work of others and then described his own work consisting of very accurate determinations of the density of pure silver after heat-treating in various ways. The results indicated the existence of at least three varieties, of silver, but it was not possible to obtain the forms each in a state of purity.

The conclusions finally arrived at were as follows: (1) Silver has a transition point at about 77 deg. C. (2) Pure silver consists of at least three allotropic forms. (3) All objects made of silver are in a metastable condition as a result of the retardation in the transition of the altered form. (4) All physical constants of silver (except the atomic weight) refer to indefinite mixtures of the different allotropic forms. New experiments are wanted to obtain constants for the different forms of silver in a pure state.

The discussion following this paper as given in *Engineering* (London) is quite interesting.

The discussion was opened by Dr. Rosenhain, who

said he found a difficulty in treating the paper seriously. He had read a lot of the papers sent out from Utrecht on alleged cases of allotropy, but so far had failed to see how it was possible to base on the experiments there made the sweeping conclusions put forward. The whole evidence was provided by measurements on density and volume. Even supposing these changes were great, would it be necessary to attribute them to allotropy? Certainly, in the cases discussed by Dr. Helderman, there was no such necessity whatever. In the first place the material used consisted of turnings, so that the metal examined had been severely cold-worked. Consequently if Beilby's view was true—and it was generally accepted—we had in the amorphous phase produced by the cold working a complete explanation of the author's observations. The temperature at which the amorphous phase began to go back was quite low, and for such changes as were noted in the paper might well occur at ordinary room temperatures. In short, before any serious attentions could be paid to claims for allotropy based on density measurements, the experiments must be made with massive silver annealed at a high temperature so as to get rid of the amorphous phase. As for the changes observed at 25 deg. C., he though the author's suggestion the least probable of any. As a matter of fact metals were not impervious to water. Thus, at the National Physical Laboratory, Mr. Sears had found that solid hammered and polished metal which it had been intended to use for standard weights would absorb an appreciable quantity of water, about one part in a million. The alloy in question consisted of equal parts of copper and nickel, but in spite of its solidity and smooth and relatively small surface, it took up by absorption or adsorption an appreciable amount of water, some of which was expelled at high temperatures. Such an absorption would readily account for all the author's results. Again, when the author found no appreciable emf. between his supposedly different varieties of silver, he did not reach the obvious conclusion that there was no allotropy, but assumed that one of his modifications persisted in both. Again, the author's contention that the expulsion of gas from a metal must necessarily increase the density was untenable, since, if the metal occupied the same volume as before, the weight would be diminished by the gas lost and a lesser apparent density would naturally result. Indeed the author's final remark completely disposed of his own paper. He stated that all the physical properties of silver so far measured referred merely to indefinite mixtures of three allotropic modifications, and would therefore all have to be redetermined. As a matter of fact, about the most accurate and consistent determination yet made of any physical constant was the electrolytic equivalent of silver. This had been measured in London, in Berlin, and in America, and the results were most consistent; and yet they were told that in such work they were dealing with indefinite mixtures.

Professor Turner said that he understood that Dr. Rosenhain did not question the accuracy of the author's measurements, but merely the conclusions arrived at. He himself had found no evidence in the paper of the three allotropic varieties postulated by the author. What were they? Did one exist above 77 deg. C., another at 77 deg., and a third below this temperature? It was obvious from the paper that there was no great volume change, and the calorimeter showed no important thermal change such as would lead to a belief in an allotropic variation. The turnings used by the author had been greatly stretched in the process of production, and rendered lighter, so that the increase of weight found on annealing should be attributed to the fact that the metal had been cold worked, rendering it amorphous.

Whether this was an allotropic change was a matter of definition, but any surface rendered smooth by buffing was rendered lighter than the mass of metal below. Dr. Rosenhain suggested that the silver had absorbed water in the author's tests. It should be noted, however, that the metal was immersed the whole time, and after a certain interval the effect of the liquid might not be very great.

Mr. Smith, who followed, said that Dr. Burgess of the Washington Bureau of Standards, had observed that there was a complete analogy between the diseases of metals and of men, the closeness of which was enhanced by the fact that in both cases some of the diseases were imaginary, being due, in the case of metals, to what Dr. Rosenhain had called "allotropy gone mad." The speaker found nothing in the author's paper which could not be explained by Stas's assumption of an absorption of gas by the metal. Silver, if heated in vacuo lost, in fact, a considerable weight of gases, and this loss was not immediate but extended over a considerable time. As an extreme case, showing the necessity of caution in interpreting changes of density, spongy gold might be taken. Water-logged spongy gold had the same density as pure rolled gold. If dried and partially annealed the density fell to about 13, and if then left in water it rose to 14 or 15, but it never recurred to the original figure. To get it back to 19 it was necessary to re-melt it, and hammer it out. He suggested, accordingly, that in the author's experiments the silver was water-logged up to 80 deg. C., at which temperature the imprisoned air on the pores to which the water had not excess, expanded. In his view the ultimate test of allotropy was whether there were changes in other properties of the metal.

Recent Chemical and Metallurgical Patents

Nickel and Cobalt

Process of Extraction of Nickel.—A patent has been granted to HENRY LIVINGSTONE SULMAN and HUGH FITZALIS KIRKPATRICK PICARD of London, England, for the extraction of nickel from its ores and particularly from garnierite ores. Fig. 1 is a flow-sheet of the various steps of the process, the main features being treating of the ore with sulphuric acid, converting the
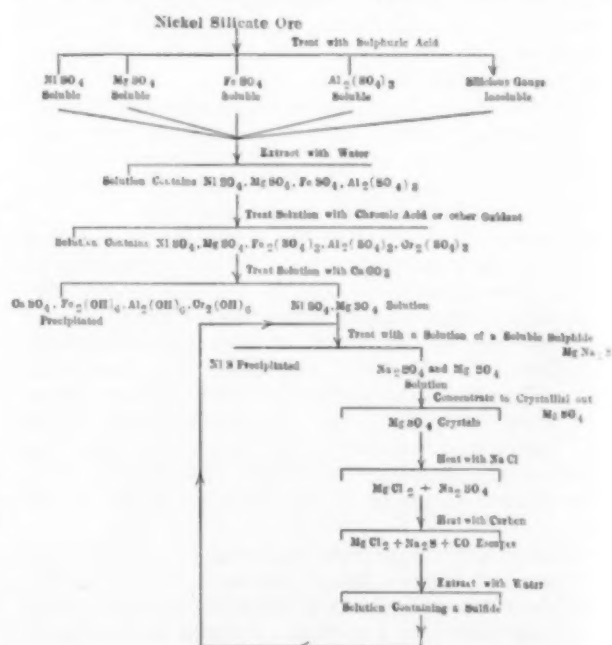

FIG. 1—THE RECOVERY OF NICKEL FROM ITS ORES

metallic constituents into the sulphates and eliminating the silica from the gangue, by washing with water. The sulphate solution is then oxidized with a strong agent, such as chromic acid and treated with calcium carbonate. This precipitates the iron, aluminium and chromium as hydroxides and leaves magnesium and nickel in solution as sulphates. The nickel is precipitated by the addition of a soluble sulphide such as sodium sulphide. The sulphide is regenerated by concentrating the solution left until the magnesium sulphate has crystallized out. The mixed mass of magnesium and sodium sulphate crystals is then calcined with sodium chloride and carbon and when cool extracted with water, giving the soluble sulphide which is reused in the process. (1,193,734, Aug. 8, 1916.)

Electrolytic Extraction of Cobalt Oxides.—A patent was granted to KENNETH S. GUITERMAN of New York, N. Y., for a method of obtaining oxide of cobalt by the electrolysis of solutions containing a cobalt salt. The essentials of the process are, that the electrolyte pass downward in respect to the electrodes, which hang vertically in the electrolytic trough; that a soluble chloride be present in the electrolyte which forms chlorine on electrolysis, which will form hypochlorite in the solution and as such act on the cobalt salt in the electrolyte; finally some agent must be added capable of preventing the formation of free acid, as this would redissolve the oxide. The neutralizing agent used by the patentee was sodium carbonate, added after the electrolyte has passed the anodes, so as to prevent the precipitation of a cobalt compound from the fresh solution. The efficiency of the process depends on the maximum amount of hypochlorite being formed and on the careful neutralization at the free acid formed during the process of electrolysis. (1,195,211, Aug. 22, 1916.)

Iron and Steel

Reducing Flue Dust.—A patent has been granted to SAMUEL L. BOGGS of Pittsburgh, Pa., for a process for reducing flue-dust and other metallic fines. The underlying principle of the process is the emptying of the flue-dust or metallic fines into molten metal, mixing and then applying a blast of gas generated in the furnace to the surface of the said mixture. The mixing of the molten metal and the dust may be conducted in any possible manner, with or without fuel and with or without extra flux. Apparatus and the mode of operation are fully described in the patent. (1,190,712, July 11, 1916.)

Copper, Lead and Zinc

Copper Coatings on Iron.—Sherard Osborn Cowper-Coles of Westminster, London, England, has patented a process for obtaining adhesive coatings of copper upon iron or steel. The process consists in first cleansing the iron or steel surface, and then rendering it passive by subjecting it to the action of concentrated nitric acid, chromic acid, or potassium hydroxid or by making it the anode in a suitable electrolyte or any other well-known method. The metal thus treated is then immediately removed to an electrolytic copper depositing tank where the copper is deposited on the passive surface in an adhesive form. The copper depositing tank should have the anode and the cathode in the electric circuit prior to the introduction of the passive metal so that the latter may be immediately covered with copper on its immersion. (1,198,703, Sept. 19, 1916.)

Brass and Copper Alloys.—A process for making brass and copper alloys has been patented by GUILLAM H. CLAMER of Philadelphia, Pa. Melted copper of the correct "pitch" is drawn off into an electric furnace.

Zinc and other alloying metals are then added in the electric furnace. The economy obtained in this process lies in the fact that large amounts of copper are melted and brought to the proper "pitch" before entering the electric furnace, that alloying is done in the electric furnace and the casting at the proper temperature. The alloying and casting can be readily accomplished in the electric furnace due to the easy regulation of the atmosphere to neutral or reducing, and to the ease with which the temperature can be controlled. Due to the regulation of the furnace atmosphere little or no zinc is lost by volatilization if zinc is used in the process of alloying. Large slabs may be cast which again is a material saving as it costs little, if anything more to handle a large slab than it does to handle a small one. (1,198,618, Sept. 19, 1916.)

Roasting Furnace for Lead Matte.—A patent for treating lead matte has been granted to UTLEY WEDGE of Ardmore, Pa. The object of the patent is to roast lead matte or similar material in a shelf furnace, and provide means for the driving off of the sulphur without causing the fusing or sintering of the matte or
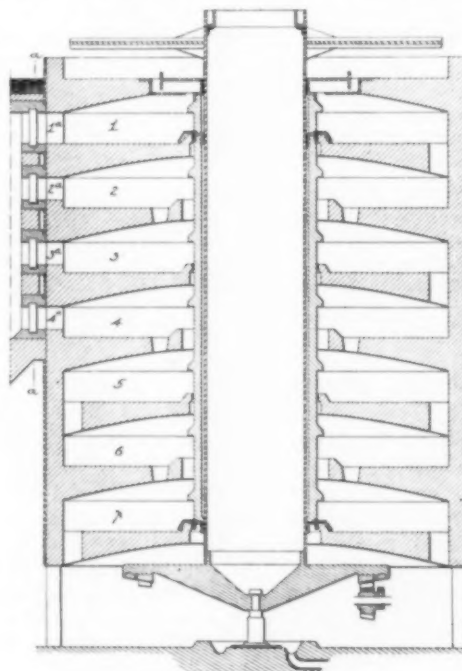

FIG. 2—VERTICAL SECTION OF LEAD MATTE ROASTING FURNACE

rendering it sticky so as to interfere with the mechanical operation of the furnace. While it has been possible to roast matte in a single-hearth furnace, the cost of fuel has been rather high, and it has been thought desirable to roast lead matte in a multiple hearth furnace if the above-mentioned improvements could be made. Wedge found, after extensive experimental work, that matte containing a considerable amount of sulphur (approximately 20 per cent) became sticky at 1400° F, but that as the roasting progressed and the sulphur contents of the matte decreased, the temperature to which the matte could be subjected without becoming sticky rose steadily, until, with a sulphur content of 13 per cent, the calcines could be subjected to a temperature several hundred degrees above 1400° F without sticking.

The principle carried out in the invention is therefore to maintain a lower temperature in the upper part of the furnace than in the lower portion. This is accomplished preferably by abstracting heat from

the gases rising from the lower to the upper chambers of the furnace. The matte passes in a counter direction to the gases. Sulphur is thus eliminated without sintering or making the matte sticky.

Fig. 2 is a vertical section and Fig. 3 a transverse section along the line a—a of the furnace. The furnace has seven treating chambers, the chambers 1, 2, 3 and
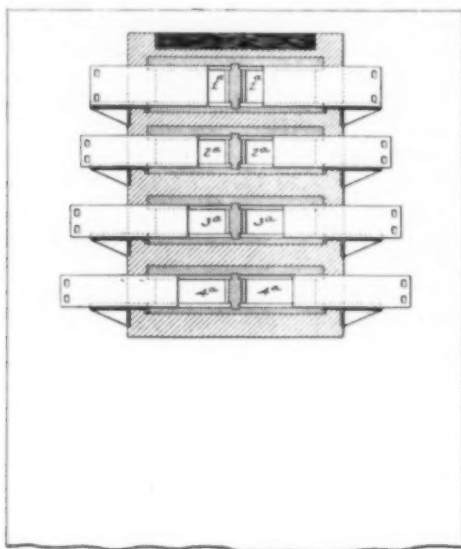

FIG. 3—TRANSVERSE SECTION OF WEDGE LEAD-MATTE ROASTING FURNACE

4 being provided with dampered outlets 1a, 2a, 3a and 4a, from which the escape of the heated gases is regulated. The control of the temperature in the upper part of the furnace may be accomplished by various means. The method employed in the furnace described is to have internal air ducts in the hearths 1, 2, 3 and 4. By means of these ducts the temperature of the hearths may be increased or lowered by decreasing or increasing the supply of air to the ducts. Another method of accomplishing the same end is to have rabble arms of such dimensions as to permit of the absorption of surplus heat by cooling fluid circulated within the rabble arms. The temperature in this case will be governed by the lesser or greater amount of fluid circulating in the arms. (1,198,882, Sept. 19, 1916.)

Recovering Copper from Solutions.—GEORGE A. SCHROTER, of Denver, Colo., and WILLIAM C. LAUGHLIN, of Nogales, Ariz., have patented a process of recovering copper from solution. Calcium hydroxide in solution is added to the solution containing the copper, followed by filtering same, roasting or calcining the precipitate so as to render the iron inert, adding sulphuric acid to the precipitate and filtering off the copper solution. (1,200,534, Oct. 10, 1916.)

Wet Copper Process.—A patent of JOHN C. GREENWAY, of Warren, Ariz., refers especially to the extraction of copper from its ores. The basic principle is that when copper-bearing solutions containing ferric sulphate are rendered neutral by repeated circulation of the solution on the ore, and are thus subjected to an excess of natural oxidized copper compounds, the detrimental ferric sulphate will be precipitated from the solution in an insoluble or partly insoluble oxide. This is then removed from the system with the mechanical moving of the tails. The chemical equation involved is: $3CuO + Fe_2(SO_4)_3 = 3CuSO_4 + Fe_2O_3$.

Fig. 4 represents one form of apparatus, which may be employed. A, B, C, D, E, F, G and H repre-
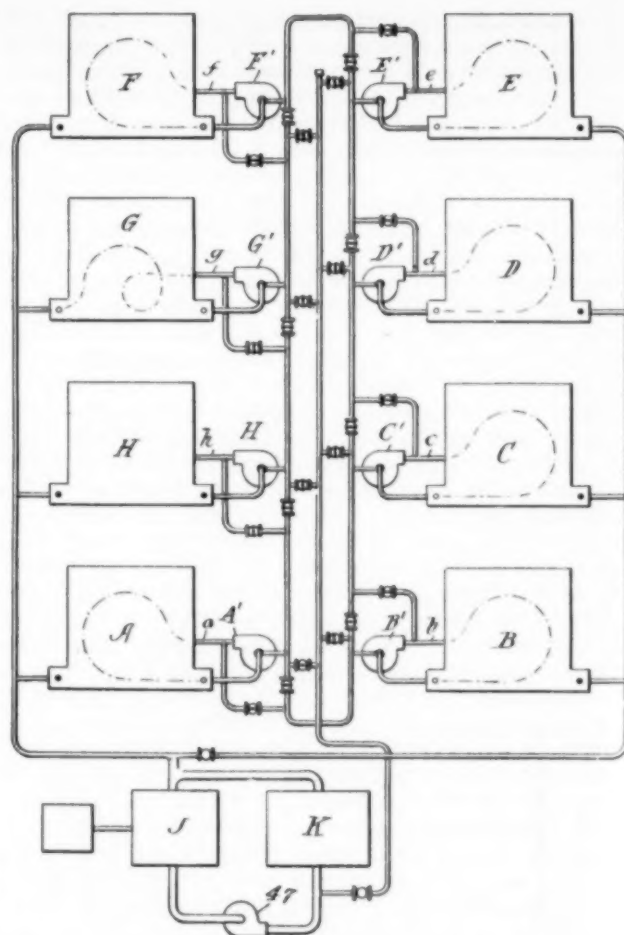

FIG. 4—APPARATUS FOR EXTRACTING METALS FROM THEIR ORES

sent a series of tanks containing the ore to be leached. In the bottom of these tanks is a perforated false bottom, which acts as a filter for the leaching solution. Tank K is the electrolytic cell, J is the sump tank and M is the tank containing the sulphuric acid used in the process of leaching. A', B', C', D', E', F', G', H' and 47 are pumps used to circulate the various solutions through the pipe system, as indicated in the drawing. The patent gives a detailed description of the apparatus and its use. (1,200,832, Oct. 10, 1916.)

Chemical Engineering

Purifying Gas in Sulphuric Acid Manufacture.—A patent granted to CARLTON F. MOORE, of Salt Lake City, Utah, applies to the purification of the dust-laden gases obtained from furnace operations, which are to be employed in the manufacture of sulphuric acid. In making sulphuric acid by the contact method it is of paramount importance that the gases be freed from all the dust or solid matter before coming in contact with the platinum catalyzer, as any dust will make the catalyzer inactive. It is the object of this patent to provide a method for continuously and economically removing, by filtration, said solid matter. The basic principle underlying this process is to remove the accumulated dust from the bags preceding the final bags of the series only. The final bag, from which the gases pass to the catalyzer, is not disturbed or cleaned, while the preceding bags may be cleaned at will to permit the successful passage of the gases. At each cleaning of the first series of fabrics a comparatively small quantity of solid material will pass through the fabric and collect on the second bag of
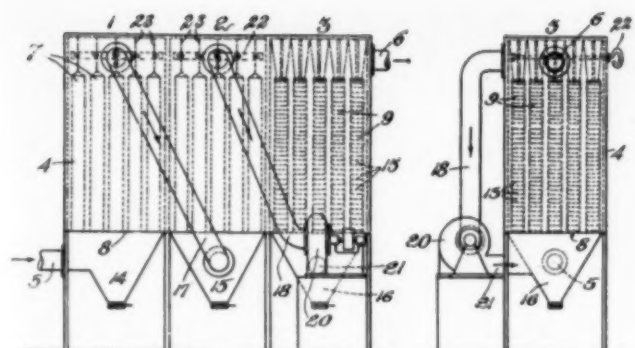
FIGS. 5 AND 6—SECTIONS OF APPARATUS FOR PURIFYING
GASES

the series. This accumulation is, however, very slow and the second fabric will require little cleaning, while the third fabric, which preferably should be the final one before entering the catalyzing chamber, needs no cleaning. To assure a complete cleaning of the gases before entering the catalyzer, the final bag, especially when new, has its interstices filled with dust before any gas is passed.

Figs. 5 and 6 show a side elevation and an elevation of a device which will answer the purpose, while Fig. 7 indicates m e a n s for supporting t h e final bag or fabric in a fixed position. The apparatus comprises a bag chamber 4, divided into three sections, 1, 2 and 3. 5 and 6 are the in- and outlet for the gases respectively. Sections 1 and 2 have bags as ordinarily used, while section 3 contains the fixed bags. These latter bags, indicated by 9, are supported in a fixed position by cylinders 10, made of wire cloth, which surround the lower thimble 11 and the upper closed thimble 12. The bags are re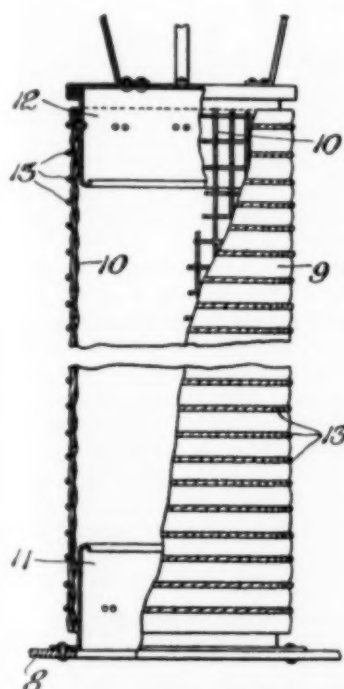tained in position on the wire cylinders by cords 13. The gases are supplied to the respective sections by means of closed hoppers 14, 15 and 16. Pipe 17 connects section 1 with hopper 15, and pipe 18 connects section 2 with a fan 20, which itself is connected with hopper 16 by means of pipe 21. (1,184,006, May 23, 1916.)

FIG. 7—SECTIONS OF APPA-
RATUS FOR PURIFYING GASES

Gold, Silver and Platinum Group

Separation of Precious Metals.—A patent has been granted to ALBERT H. SHERWOOD, of Oroville, Cal., for a process of separating metals. The invention relates especially to treating pulp, black sands, concentrates and other materials for the separation therefrom and the recovery of the precious metals—gold, platinum, palladium, osmium, iridium, ruthenium and rhodium. The material is finely or coarsely ground, as circumstances may demand, and placed in a suitable receptacle.

Enough 15 per cent to 25 per cent sulphuric acid is added to saturate and cover the pulp, followed by stirring until thoroughly mixed. Then it is allowed to stand from thirty to forty minutes. This treatment causes the pulp to become puffy and light, and the values are cleansed from oxides, grease, etc. The acid thus used has not exhausted its strength and is reused.

In a second receptacle, consisting of a clean iron pan, an amalgam bath is made, consisting of ½ lb. of 25 per cent copper sulphate solution, 1 lb. of copper sulphate crystals, and 5 to 7 oz. of mercury. A few drops of sulphuric acid are added and the mass is thoroughly ground. The mercury combines with the copper solution forming an amalgam, which adheres to the side of the pan. The contents of the first receptacle are added to the second and subjected to agitation for about one hour. The copper solution then penetrates the pulp and coats the native metals, while the sulphuric acid maintains the pulp and minerals in a suitable condition for rapid amalgamation. After the prescribed agitation, water is admitted slowly, agitation being maintained constantly, and the native metals are washed and amalgamated with the copper amalgam.

The amalgam is washed and removed to a third receptacle and treated with 50 per cent nitric acid. Mercury, silver, copper and lead go in solution, while the gold, platinum, iridium, etc., remain undissolved. The solution is removed and a solution of cobalt nitrate is added in its place. The strength of the cobalt nitrate solution is 12 per cent. This is allowed to stand in contact with the residue for five to ten minutes and then pure mercury is added. The amount of mercury required is from ½ to 1 oz. The function of the mercury is to amalgamate the gold. The gold amalgam is then removed to a fourth receptacle. The residue left in the third vessel is treated with 50 per cent nitric acid. This acid removes any mercury and cobalt. This solution is removed and the residue containing platinum, palladium, iridium, osmium, etc., is thoroughly washed. The effect of the cobalt nitrate solution with the mercury is to liberate the gold from the metals of the platinum group. (1,192,945, Aug. 1, 1916.)

Electrolytic Processes

Sodium Amids.—A process for the manufacture of alkali-metal compounds has been patented by EDGAR A. ASHCROFT, of London, England, particularly the production of sodium or potassium amids from sodium or po-
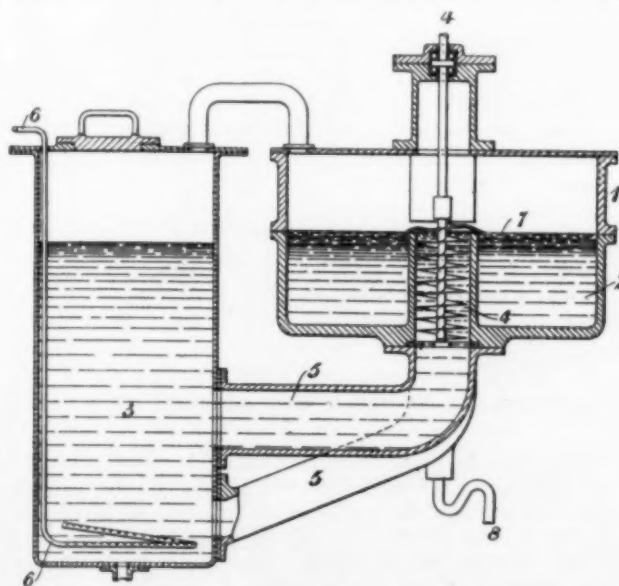

FIG. 8—VERTICAL SECTION OF ELECTROLYTIC CELL

tassium alloys. Amids, cyanamids and cyanides, when brought into contact in the fused state with alloys of the alkali metals will dissolve large amounts of the alkali metals without attacking the other metallic constituent of the alloy. The lead-alkali alloys are preferred in the process. The most economical lead-alkali alloys to be used are those containing 5 per cent sodium or 6 per cent potassium. The temperature at which the alloys must be maintained is 400 deg. C. or more, as below this temperature the reactions taking place are much retarded. The temperature of the fused amid should not exceed 440 deg. C. for sodium and 400 deg. C. for potassium, or otherwise decomposition will take
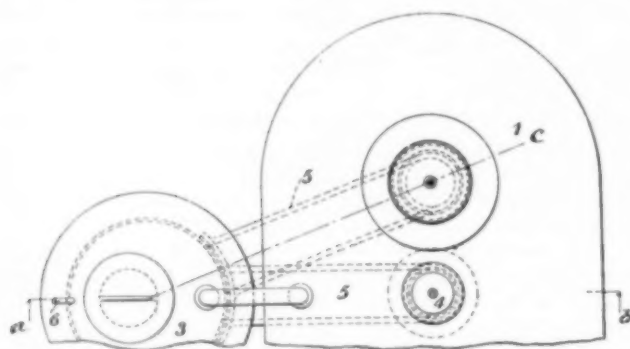

FIG. 9—PLAN OF APPARATUS

place. The one essential condition is, that there should be good contact between the alloy and the fused amid.

The apparatus is shown in Figs. 8, 9 and 10. Fig. 8 is the secondary cell in connection with any electrolytic or other alloy producing apparatus. An electrolytic cell for the production of the alloy is advantageous, as the alloy may then be produced continuously. The alloy 2 circulates through cell 1; 3 is the amid kettle; 4 the pump for circulating the amid and 5 the well and circulating pipes to kettle 3; 6 indicates the inlet pipe for ammonia or the like. The surface of the moving amid or other products is indicated at 7. The alloy for this
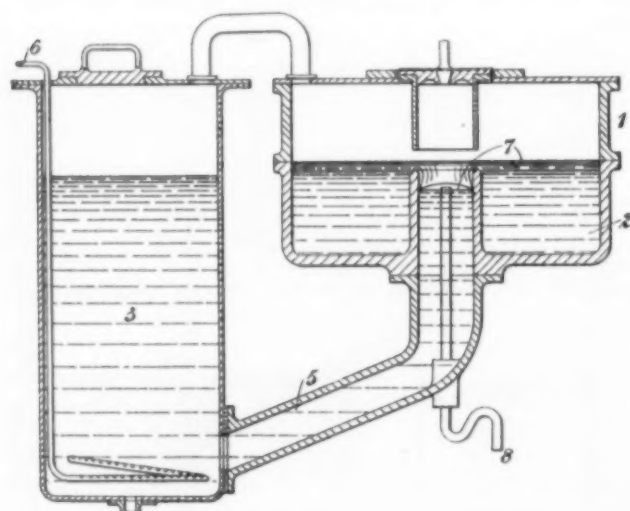

FIG. 10—MODIFIED CELL CONSTRUCTION

process may be produced preferably in an electrolytic cell, this forming the first receptacle of the process, while the above described apparatus constitutes the second one. The whole process then works continuously for the production of amids. Cyanides, cyanamids and other compounds may be produced similarly. (1,197,-329, Sept. 5, 1916.)

A Rapid Coal Unloader

The machine shown in the accompanying illustration was designed primarily for unloading cars in which the coal had frozen. It has, however, proven to be a very useful machine at any time of the year as it unloads a 50-ton coal car in 5 to 6 minutes, forcing the coal into the track hopper. The origin of the machine makes an interesting story.

The Edison Illuminating Company of Detroit had for many years experienced considerable difficulty in unloading a sufficient amount of coal to meet the load demand at its power houses during the winter season when the coal had become frozen in the cars. As received by this company during the winter season, the coal is frozen at the top and bottom of the car for a distance of about 2 ft., and often throughout the entire depth of the car. In either case the coal would not flow from the car when the doors were opened and it would be necessary to force an opening by driving a small pipe with a hand hammer through the frozen coal at several places. This operation required from 30 to 90 minutes. After an opening had been made the coal was loosened by picks. The whole work of unloading a car would require from 1½ to 4 hours, depending upon the degree to which the contents were frozen.

Mr. J. P. Considine, engineer with the Edison Company, planned and patented the machine as shown here, for speeding up this unloading.

The coal breaker and scraper consists of a carriage supported by, and traveling longitudinally on a girder runway, and two spuds with air hammers carried by the carriage. The carriage, weighing 15 tons, is held in position by four doubled-flanged wheels which run on the top of the runway girders, and is driven by a 22-hp. variable-speed motor through pinions that mesh into racks fastened to the bottom of the girders. Another method for propelling the machine along the runway is by cables dead ended at each end of the runway and connected to the traveling motors on the machine. Either of these arrangements affords a positive drive that does not depend upon the tractive effort of the flanged wheels. The travel motor is provided with a solenoid brake for promptly arresting the high speed parts of the mechanism when the current is shut off. A limit device is also provided for the travel mechanism, to prevent running off the runways. The carriage carries two spuds, each weighing 4½ tons and each hung by a cable.

In the spud above the anvil block there is a double acting air hammer weighing 3400 lb. to which is connected a flexible air hose. The two spuds occupy approximately the full width of the car. One or both may be operated at a time, being raised by one 52-hp. variable speed motor. The hoist motor is provided with a solenoid brake, and there is a limit device to prevent overhoisting.

In the illustration the spuds are shown lowered to a position at which the elevation of the lower ends corresponds to the height of the car floor. When the machine is not operating the spuds are carried at the highest position, the lowest extremity being on a line with the bottom of the carriage.

As shown in the illustration the bottoms of the spuds are cut out at the inner side, thus allowing them to clear the center beam on hopper bottom cars. A small portion of the coal escapes through the opening between the spuds but this is negligible in amount and can be removed quickly with shovels.

When a car is to be unloaded it is placed over the hopper and the doors dropped. If necessary as in the case of frozen coal, the spuds on the machine can start the coal flowing through the doors. The machine is
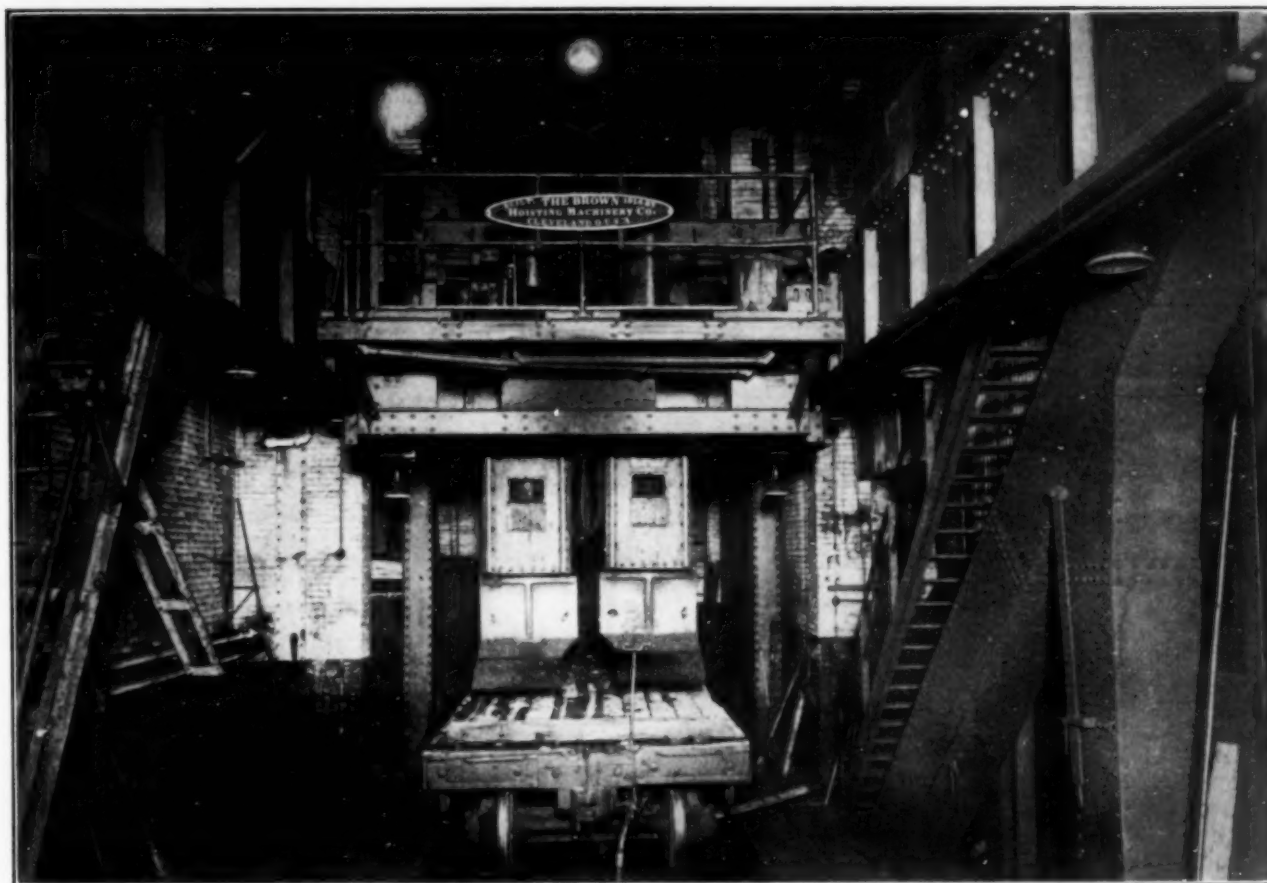
GENERAL VIEW OF UNLOADER SHOWING SPUDS IN LOWEST POSITION

run to one end of the car and the spuds lowered into the coal and then the machine is run forward scraping the coal toward the doors and dropping it into the hoppers. This is repeated on the other end. As stated before it requires from 5 to 6 minutes to clean the car.

This machine was first put to work in May, 1914, and has been in continuous operation since then. It is now being generally placed on the market by its makers, the Brown Hoisting Machinery Company, Cleveland, Ohio.

The Chemical and the Mineral Industry of French Indo-China

In Tonkin there are at the present time nine tanneries, one situated at Hanoi and owned by La Société des Tanneries de l'Indochine and eight smaller ones in the vicinity of Haifong owned by Chinese interests. The Hanoi establishment used 40,000 hides in 1915 while the Chinese factories used from 15,000 to 20,000. The output of the leather products for the year 1915 amounted to $100,000.

There is a paper mill at Dapcau and a pulp mill at Vietri, both in Tonkin. Starting operations late in 1914, the paper mill at Dapcau turned out approximately 1200 tons of coarse paper made from rye straw, mulberry bark, bamboo and the like, the product being sold on the local market. The Vietri plant, which produced pulp from bamboo, shut down late in 1914, due to lack of management, and has not been reopened since.

The two soap factories, one situated at Haifong and one at Saigon, turned out approximately 1400 tons of soap in the year 1915. Of this the Haifong plant produced 1200 tons and the much smaller factory at Saigon 200. The soap produced by the Haifong establishment was valued at $150,000, which value was raised to $200,000 by the by-products. These figures show a 100 per cent increase over the year 1914, which was mainly due to the removal of European competition.

The three factories in Anam producing albumen from the whites of duck eggs are: the plant of Derobert et Fiard at Hue, consuming approximately 2,500,000 eggs during the two seasons, September-February and March-July; that of Murat at the same place consumes the same amount; and the establishment of Derobert et Fiard at Quinhon consumes 10,000,000 per year. The entire production for the year 1915 was 66,138 lb. of dried egg albumen, valued at $15,000, and 595,248 lb. of liquid egg yolks, valued at $25,000. This shows a decline of 50 per cent in market value

Minerals	1914		1915	
	Metric Tons	Value	Metric Tons	Value
Coal	360,000	$1,340,000	400,000	$1,500,000
Zinc	19,562	463,248	33,335	790,000
Tin and tungsten	216	112,500	397	207,000
Antimony	920	35,500	630	24,360
Salt	20,347	78,539	27,326	93,460
Cement	30,689	473,835	50,000	750,000
Gold ore, grams	154,900	*80,000	98,532	*50,000

*Estimated.

NOTE: The figures given are low mainly for two reasons: (1) The ores run unevenly, and (2) the custom values are low as compared with the actual market prices, i.e.; The custom value of coal is 20 francs, or $3.86 per ton, while the market value at the present time is about 50 francs or $9.65. Therefore the coal exported for the year 1915 at the actual market price would amount to $3,500,000 instead of the value given in the table. Similarly for zinc: The custom value for zinc ore is 130 francs per ton or $25.09, while the actual market price fluctuates around 300 francs or $57.90. The value of the zinc shipments for 1915 corrected is therefore $1,930,096. The market prices for tin, tungsten and zinc ores shipped from Haifong is 3 to 10 times as great as the custom figures given above. (Same reference.)

from the figures of 1914 and is due to cost of freight and loss of market. The products were generally sent to France, but a large quantity of the liquid egg yolks had, previous to the war, found an outlet in Germany.

The total production of matches in 1915 was 22,000 cases of 7,200 boxes each, valued at $650,000, and showed an increase of about 10 per cent over the year 1914. This increase is due to the fact that the industry has captured the total French Indo-China market. Two factories are operated by La Société Indochine des Allumettes, one being at Hanoi and one at Ben-thuy, and one at Ham-rong, near Thanh-hoa, is operated by La Société des Allumettes de Thanh-hoa.

The mineral production of French Indo-China may best be shown by a table taken from the Supplement to Commerce Reports, Oct. 16, 1916:

Increasing Stability of Bitumens by Introduction of Colloids

An interesting application of colloidal chemistry is described in patents recently issued to CLIFFORD RICHARDSON, consulting engineer with the Barber Asphalt Company, on an improved bituminous substance and on the process of manufacture (U. S. Patents 1,198,769, Sept. 19, 1916, and 1,198,955, Sept. 19, 1916). Patents have also been granted in several foreign countries. The process consists in the introduction of clay in the form of a colloidal solution into the bitumen in such a way that when the water is subsequently driven off the product has a greater degree of stability than formerly obtainable. The process was discussed in a general way in a paper on "Asphalt" read at the symposium on colloids of the recent New York meeting of the American Chemical Society. The process is applicable to residual pitches from petroleum distillation and coal-tar pitches as well as native bitumens.

It is well known that the addition of finely divided mineral matter to bituminous substances increases their stability, and this knowledge has been used in manufacturing paving materials and in other arts. By the new process a greater resistance to deformation under pressure is obtained. Finely divided clay in the colloidal state, made by combining the clay with water in the form of a paste, is added to the bitumen. With highly colloidal clays three parts of water to one of clay are used. With poorer clays more water is used. The method of adding as given in the specification is as follows:

"This paste is added to a bituminous substance in proportions varying with the character of the substance and the object for which the material is to be used. The amount of disperse colloid should be at least 1 or 2 per cent, but may be increased to any percentage at which the bitumen will melt and flow. But if the proportion of clay is too large, the bitumen is incapable of constituting a continuous phase in relation to the clay, and accordingly instead of matter in a colloidal state there results a mere mixture, which does not constitute my invention. Proper agitation of the paste and the bitumen with steam or air will effect uniform emulsification of the two components. The water with which the disperse colloid has been associated is then removed as by evaporation."

An example of the process as used for making paving material is given as follows:

"I may add to any crude petroleum, maltha or liquid residuum from the distillation thereof, or to any form of bitumen sufficiently liquid below the temperature of boiling water, to make an emulsion with the clay paste, from 20 to 50 per cent of a liquid paste consisting of water and clay containing disperse colloidal matter, varying in amount according to the quality of the clay, but, of course, the more desirable the larger percentage of this material, although the coarser portion may be looked upon as desirable as an ordinary filler, although undesirable if it is sufficiently coarse to settle out during distillation and thus form a cake or coke upon the walls of the still. This combination is emulsified by passing through it steam or air or by other means of agitation, and evaporating the water, incidentally in some cases distilling off some or all of the more volatile portions of the bitumen, according to the uses to which the resulting residual pitch is to be put in the preparation of asphaltic cements for paving mixtures."

The products resulting from this process have markedly different properties from products in which the mineral matter is introduced as a dry powder. The products vary in strength and range from materials resembling hard vulcanized rubber to stable plastic mixtures suitable for paving and other uses.

Personal

Mr. A. P. Allen, recently with the Calumet & Hecla, has resigned his position, and is now with the Highland Mining Company, at Ashcroft, B. C., Canada.

Mr. J. W. Bumgardner has resigned his position as metallurgist of the Becker Steel Company of New York, and has become associated with the Wheeling Mold & Foundry Co., Wheeling, W. Va., in the roll department.

Mr. H. L. Christensen, formerly mill superintendent at the Miami Copper Co., has accepted a similar position with the Alaska-Juneau Gold Mining Co.

Mr. Nels C. Christensen, recently connected with Bureau of Mines of the University of Utah, has left for southern Utah, to build a mill for the Big Indian Copper Company. The mill will handle low grade, oxidized copper ores, and will be of a new type, embodying the principles of the process devised by Mr. Christensen and H. J. Morgan for handling such ores.

Mr. W. L. Clark has resigned as manager of the United Verde Copper Company, at Jerome, Arizona. His successor is R. E. Tally, for many years connected with the company in the capacity of mines superintendent.

Mr. H. B. Coho, widely known as the former secretary of the New York Section of the American Electrochemical Society, has returned from Lowell, Mass., where he was sent by the United Lead Co. to organize the business departments of the U. S. Cartridge Co., and is now back at his old desk at the United Lead Company's offices at 111 Broadway, New York, in charge of their research work. How well he succeeded at Lowell may be judged from the following quotation from a speech made by Mr. E. H. Schell at a banquet given in Mr. Coho's honor on the occasion of his leaving Lowell. After referring to Mr. Coho's extended welfare work he said: "One of the most prominent men in labor matters in New England made the statement when he heard of Mr. Coho's return tc New York that his going would mean a real loss to the Commonwealth of Massachusetts. We cannot keep Mr. Coho in Massachusetts, but we can do our best to maintain the manifold industrial structures which he has reared for our benefit, and we can bid him Godspeed and good luck for the future."

Mr. Sidney Cornell has been appointed heat-treating engineer of the Remington Arms Union Metallic Cartridge Company, Inc., at the Remington Bridgeport Works, and will have supervision of the annealing,

hardening and heat-treating operations, which in future will form a separate department of the company.

Mr. **W. R. Degenhardt,** metallurgical engineer for the Burma Corporation, Ltd., British Burma, passed through Salt Lake City on an inspection tour of the large mining districts in the western United States.

Mr. **J. F. Erisman** of Denver, Col., general manager of the Blue Flag Gold Mining Company, has inspected the properties of said company in Idaho.

Mr. **A. N. Fox** has resigned his position as advertising manager for the Benjamin Electric Mfg. Company and has accepted the presidency of the R. & F. Copper Company of Nevada, with headquarters in the Harris Trust Building in Chicago.

Mr. **W. F. Grace,** manager of the Waihi Grand Junction mine, New Zealand, has gone to Sidney, Australia, to recover from the effects of a long illness.

Mr. **Jay P. Graves** of Spokane, one of the managers of the Granby Consolidated Co., has retired as director and his successor is **Henry Bruere** of New York.

Mr. **E. H. Hamilton** is the new metallurgical manager for the Trail smelter of the Consolidated Mining & Smelting Co. of Canada.

Dr. **Edward Hart** has retired as active head of the department of chemistry of Lafayette College, and will be succeeded by Dr. **Eugene C. Bingham,** professor of chemistry at Richmond College. Dr. Hart will remain connected with the department as professor of chemical engineering, and will also remain in charge of the Henry W. Oliver chemical library.

Mr. **E. L. Hiatt,** after resigning his position as chief engineer with the Ray Consolidated Copper Company, was made manager of the Arizona Ray Copper Company.

Mr. **T. P. Holt,** superintendent of the Tintic Milling Company, is back at the plant after a long absence in the South and in the East. At Norfolk, W. Va., Mr. Holt supervised the installation of two of the Holt-Dern roasters, which are now being successfully used at the Virginia Smelting Company.

Mr. **Louis D. Huntoon** has completed the examination of several mining properties in South Dakota.

Mr. **A. W. Jenks** is the new smelter superintendent of the Burma Mines Corporation, Ltd., in British Burma.

Mr. **W. C. Madge,** connected with the Irytsh Corporation, Ltd., arrived at Spokane in the middle of October from the Ridder mining concessions in Siberia. He expects to stay in the United States about one month, and will then sail for the company's headquarters at London.

Mr. **W. O'Neil** has been appointed general manager of the Janet Copper Mining & Milling Co., located near Vernal, Utah.

Mr. **E. L. Newhouse** paid a visit to the Butte-Duluth property at Butte.

Dr. **L. D. Rickets** has been traveling through Arizona, inspecting various copper properties.

Mr. **L. C. Schultz** has joined the staff of Hamilton & Hansel, 17 Battery Place, N. Y., agents for the Rennerfelt electric furnace.

Mr. **J. C. Simmons,** manager of the Rare Metals Mining & Milling Co., at Telluride, Col., has visited New York City on company business.

Mr. **F. Steffer** is supervising the construction of a new custom mill of 500 tons daily capacity at Chloride, Ariz.

Mr. **E. Gybbon Spilsbury** has gone to Cuba on professional work and will be absent about three weeks.

Mr. **M. J. Welch** has returned to Los Angeles, Cal., after having supervised the construction of an experimental concentrator for the Cerro de Pasco Company in Peru.

Mr. **Norman L. Warford,** who has been in charge of the powdered coal department of the Anaconda Copper Mining Company, Anaconda, Mont., has become connected with the Powdered Coal Engineering & Equipment Company of Chicago, Ill., in the capacity of engineer in charge of construction. Mr. Warford is credited with having installed the largest powdered coal plant in the United States, for the Anaconda Copper Mining Company at its several works, wherein they burn approximately 1000 tons of pulverized fuel every day.

Obituary

William Cooper Cuntz, general manager and director of the Goldschmidt Thermit Company, New York, died on Thursday morning, Nov. 2, 1916, at Auburndale, Mass., where he was on a visit for the benefit of his health which was impaired by an operation for appendicitis a year ago. Mr. Cuntz was the son of the late Emil A. H. Cuntz and Frances Cooper Cuntz and was born at Hoboken, N. J., in 1871. He attended the Hoboken Academy and Stevens Institute of Technology, graduating in 1892 with the degree of mechanical engineer. He then became connected with the Pennsylvania Steel Company of Steelton, Pa., first with the bridge and construction department and later with the sales department, which he represented in many important capacities in Boston, Philadelphia, London (England) and in Steelton. In 1910 he severed his connections with the steel company to become a director and the general manager of the Goldschmidt Thermit Company of New York. At the time of his death he was also a director of the Goldschmidt Detinning Company.

David Colville, managing director of David Colville & Sons, Ltd., English steel manufacturers, was taken ill in his office at Motherwell, England, on Saturday, Oct. 14, and died at his residence in Motherwell the following Monday.

Book Reviews

Catalysis and Its Industrial Applications. By E. Jobling. Duodecimo (12 x 15 cm.), 120 pages, 12 illustrations. Price, $1.00. Philadelphia: P. Blakiston's Sons & Co.

This is a reprint from "The Chemical World." Revision and extension were prevented by the author enrolling in the British Army, so the reprint is verbatim. It is a useful and informing little book. We wish it had been longer, since it is written with a full command of the available facts and theories, and as much definiteness as the present state of science will permit.

* * *

The Corrosion of Iron. By L. C. Wilson. Duodecimo (12 x 19 cm.), 178 pages. Price, $2.00. New York: The Engineering Magazine Co.

A brief but clear statement of the general aspects of the problem. It will be useful to the general reader, or as an introduction to the larger works of Cushman or of Friend. About half the book is a discussion of external preventive measures, but the influence of composition (manganese, copper, carbon, etc.) and the theories of corrosion are skilfully summarized.

INDUSTRIAL

Financial and Construction News

Financial

The Aetna Oil & Gas Company, Nashville, Tenn., has been incorporated with a capital of $25,000. The incorporators are G. M. Whiteson, Jacon Piere, D. B. Snyder and others.

The American Graphite Company, Gadsden, Ala., has been incorporated with $100,000 capital to mine graphite.

The American Kelp & Chemical Industry, Inc., has been incorporated with a capital of $100,000. Incorporators are Frank Messedate and C. H. Grimstad.

The American Mixing & Beating Machine Company, Inc., Brooklyn, N. Y., has been incorporated with a capital of $50,000 to manufacture mixing machines. The incorporators are J. Trust, F. P. Roth, H. Fischer.

The Atlantic Dyestuff Company, Boston, Mass., has been incorporated with a capital of $50,000. Incorporators are Montgomery Reed, Albert C. Burrage, Jr., Thomas W. Nason.

Atlantic Paper & Pulp Corp. has been incorporated with a capital of $250,000 to manufacture paper pulp. The incorporators are M. T. Nicholas, D. T. Wells, R. N. Sheffy, of Glen Ridge, N. J.

The Belmont Petroleum Company, Tulsa, Okla., has been incorporated with a capital of $15,000. Incorporators, T. L. Brown, A. L. Poole, D. C. Tucker and T. B. Hodgden.

The Blossburg Mining Co., Cardiff, Ala., has been incorporated with $2,000 capital. The officers are: William Robson, president; Tom M. Dickey, vice-president, and P. R. Jordan, secretary-treasurer.

The Bodine Chemicals & Color Co., Inc., has been incorporated in New York State with $10,000 to engage in business in chemicals, dyes, etc. Incorporators are G. Feinberg, E. D. Holland, A. C. Horn.

The Bridgewater Chemical Company has been incorporated in Delaware to manufacture chemicals. Capital, $200,000.

The Brightwood Oil Company, Indianapolis, Ind., has been incorporated with a capital of $50,000 to drill for oil and gas. The incorporators are Horace W. Nordyke, Erwin H. Sheil, Gilbert P. Inman.

The Camel Oil Corpporation, Oklahoma City, Okla., has been incorporated with a capital of $25,000. Incorporators, A. A. Zalondek, J. Gerald Marz and D. K. Pope.

The Canton Oxygen & Hydrogen Company, Pittsburgh, Pa., has been incorporated in Delaware with a capital of $200,000 to manufacture and deal in oxygen and other chemicals. Incorporators are F. H. McCarthy, C. W. Meily, J. H. Haverty, all of Pittsburgh.

The Carlton Manufacturing Company, Portland, has been incorporated with a capital of $150,000, par $100. The officers are: President, Clement F. Robinson; treasurer, Raymond S. Oakes; clerk, Robert T. Whitehouse.

The Carolina Products Company, Bandana, N. C., has been incorporated with a capital of $100,000 to engage in mining feldspar.

The Chattanooga Mirror Works, Chattanooga, Tenn., has been incorporated with a capital of $25,000 to manufacture mirrors and other glass products. The incorporators are Carl Grau, Otto J. Bubbuch, W. A. Aultman, J. M. Mitchell, G. C. Roul.

The Cheboygan Paper Company, Cheboygan, Mich., has been sold to the Union Bag & Paper Company. Majority control was obtained at a cost of $1,550,000. The Union Bag & Paper Co. is capitalized at $27,000,000 and manufactures paper bags in various parts of the country.

The Chicago Glass Products Co., Chicago, Ill., has been incorporated with a capital of $20,000. The incorporators are George Levy, Ida Miller, Thomas M. Whitson.

The Chicago-Kenosha Hosiery Company, said to be the largest stocking plant in the world, the Sheboygan Knitting Company, and the Cooper Mfg. Co., of Bennington, Vt., have been purchased by the Black Cat Textile Company, capitalized at $3,000,000. C. C. Allen of Kenosha, Wis., is president of the new company.

The Chromos Chemical Company, Inc., New York City, has been incorporated in New York State with a capital of $90,000. The incorporators are N. R. Green, G. E. Mosset, D. I. Straus, of Aeolian Hall, New York.

The Consolidated Rolling Mills & Foundries Company, Inc., Wilmington, Del., has been incorporated with a capital of $1,000,000; representative, Geo. D. Wright, 25 Broad Street, New York.

The Continental Refining Company, Bristow, Okla., has been incorporated with a capital of $1,300,000.

The Creighton Valve Company, Inc., Maspeth, L. I., has been incorporated with a capital of $15,000 to deal in metal valves. The incorporators are G. S. Jervis, R. Kunze, W. L. Woodhill, 26 Ely Avenue, Long Island City.

The Crude Oil Producing Company, Dover, Del., has been incorporated with a capital of $500,000 to buy, sell and lease oil and gas lands. Incorporators are F. D. Buck, M. L. Horty, K. E. Longfield, Wilmington, Del.

The Decatur Straw Board Company, Decatur, Ind., has been incorporated with a capital of $25,000 to manufacture straw board paper, etc. The incorporators are John W. Vail, Dan R. Vail and F. E. Vail.

The Deeds Commercial Laboratories, Indianapolis, Ind., has increased its capital stock from $10,000 to $50,000.

The Dissoway-Schad Company, Brooklyn, N. Y., has been incorporated with a capital of $14,000 to manufacture chemicals. The incorporators are Thurston N. Dissoway, Frank N. Lesinsky.

The Eagle Chemical Works, Inc., has been organized with $10,000 capital to manufacture printing and lithographing materials, inks, etc. The incorporators are A. Katz, J. J. Murray and J. Frank, of 792 East 175th Street.

The Eastern Oil Company, Cleveland, Ohio, has been incorporated with a capital of $10,000. The incorporators are F. R. Wall, P. A. Wall, C. D. Woodyatt, E. L. Woodyatt, R. T. Morrow.

The Electro-Amalgams Corporation, New York, N. Y., has been incorporated with a capital of $5,000 to establish a system for the electro-chemical purification of water and other processes. The incorporators are E. O. Towne, H. W. German and B. B. Cromble, 169 West 80th Street, New York.

The Elem Asphalt & Oil Company, Kansas, with a capital of $400,000, has been authorized to conduct business under the laws of Missouri.

The Enterprise Foundry Company, Wilmington, Del., has been incorporated in Delaware with a capital of $50,000 to carry on the business of operating foundries, etc. The incorporators are John Myers, Louis A. Hillersohn, William H. Myers, all of Wilmington.

The Federal Color & Chemical Co., Boston, Mass., has been incorporated with a capital of $25,000. The directors are Benj. A. Levy, president; Samuel Markell, treasurer, and E. M. Batts.

The Flash Chemical Company, Greenville, S. C., has been incorporated with a capital of $1,000. The incorporators are L. W. Arrington, M. C. Westervelt and E. G. Fowler.

The Friars Chemical Company has been incorporated in Delaware with $500,000 capital by G. E. Fooks, K. M. Dougherty and L. S. Dorfe of Wilmington.

The General Coal Tar Products Company has been incorporated in New York State with $50,000 capital by S. A. Davison of Rockville Center, C. E. Abrams of East Rockaway, and J. H. Griffiths of Long Beach.

The Gilliland Oil & Gas Company, Dover, Del., has been incorporated with a capital of $8,000,000 to deal in oil and gas. The incorporators are J. L. Skinner, H. E. Latter and N. P. Coffin.

The Grace Nitrate Company, Dover, Del., has been incorporated with a capital of $4,000,000 to explore for caliche or nitrate. The incorporators are M. M. Hirona and J. B. Bailey.

The Guarantee Refining Company has been incorporated in Delaware to acquire and develop oil and mineral lands. Capital

$500,000. Incorporators, F. D. Buck, M. L. Harty, K. E. Longfield, of Wilmington, Del.

The Hammerill Company, Erie, Pa., has been incorporated to manufacture paper by W. P. Clifford, Albert O. Chapin and Henry E. Fisk.

The Hennepin Copper Company, Portland, Me., has been incorporated with a capital of $1,000,000 to manufacture and deal in all kinds of ores, metals and minerals. The incorporators are Joseph W. Hawes, Boston, Mass.; Robert T. Whitehouse, John B. Thomas, Portland, Me.

The Henry-Miller Foundry Company, Canton, Ohio, has been incorporated with a capital of $150,000. The incorporators are Thomas E. Henry, Charles J. Miller, Elmo S. Moncrief, Jacob W. Steiner, James K. Lynch.

The Howland Pulp & Paper Corporation of Brattleboro, Vt., has increased its capital stock from $50,000 to $300,000.

The Hudson Trading & Investment Company has been incorporated in Delaware to acquire and develop oil and mineral lands. Incorporators are J. C. Williamson, London, Eng.; E. R. Cleaver and A. P. Hallett, New York City.

The Hygienic Products Company, Wilmington, Del., has been incorporated in Delaware with a capital of $100,000 to prepare and compound chemicals, drugs, etc. The incorporators are Herbert E. Latter, Norman P. Coffin, Clement M. Egner, of Wilmington.

The International Potash & Fertilizer Company, Los Angeles, Cal., has been incorporated. Their intention is to build a factory for the production of potash from kelp. Organized by R. S. Oppenheim and others.

The Johnstown Paint & Glass Company, Johnstown, Pa., has been incorporated with $25,000 capital by H. K. Watson of McKeesport, Harry M. Stull and Joseph Ginsberg of Johnstown, and E. K. Collingwood of Pittsburgh.

The Kelly Fertilizer & Oil Mill Co. has been incorporated in Delaware with $25,000 capital. The incorporators are F. D. Buck, M. L. Horty and K. E. Longfield, of Wilmington.

The Kentucky Oil & Gas Company has been incorporated in Delaware with a capital of $250,000 to develop the Kentucky oil fields. The incorporators are Samuel Reiner, Jesse Cohen and John Papulias. Valuable leases in Knox County, Ky., have been secured and wells will be sunk. The Kentucky fields were abandoned years ago on account of the low price of crude oil.

The Lightenhome Oil & Refining Company, New York, has been incorporated with a capital of $1,000,000 to produce petroleum products. The incorporators are Charles Lightenhome, Maurice Cohen and William J. Shalvey.

The McCausland Engineering Company, Dover, Del., has been incorporated in Delaware with a capital of $3,000,000 to manufacture iron, steel and other metals and to do a general mechanical engineering business. The incorporators are F. R. Hensell, George H. B. Martin, S. C. Seymour, all of Philadelphia.

The Maryland Tube Corporation, Baltimore, Md., has been incorporated with $500,000 capital and plans the erection of a tube, bar and sheet mill and brass foundry in Baltimore. The incorporators are Herbert B. Stimpson, Charles H. Birmingham and Heyward Taylor.

The Mercantile Paper Products Company, Bronx, N. Y., has been incorporated with a capital of $5,000. Business, paper products and compounds. The incorporators are E. Goldman, L. and E. M. Geiger, 819 Manida St., Bronx.

The Mirrolike Manufacturing Co., Inc., is a new company organized in New York with $100,000 capital to manufacture polishes, chemicals, etc. Incorporators: G. Schnoor, G. Stoye and T. H. Moech, 2734 Kingsbridge Terrace, Bronx.

The Monster Chief Mining Company, Wilmington, Del., has been incorporated with a capital of $2,000,000 to conduct mining operations. The incorporators are M. L. Rogers, L. A. Irwin, Harry W. Davis, Wilmington, Del.

The Mount Airy Coal Company, of Mahaffey, Pa., has been chartered in Delaware to carry on a general mines and colliery business and to manufacture coke. Capital $200,000. Incorporators: F. M. Miller, Pittsburgh; H. Adlin, MacDonald, N. Y., and Clara T. Ledig, Mahaffey, Pa.

The New York Zinc Company, Wilmington, Del., has been incorporated with a capital of $1,000,000 to manufacture and sell zinc, ores, etc. The incorporators are N. P. Coffin and C. M. Egner.

The Pacific Metals Corporation, New York City, has been incorporated with a capital

of $100,000 to conduct dredging and mining, etc. The incorporators are E. M. Allen, S. B. Howard, L. H. Gunther, 28 Nassau St.

The Painted Post Oil, Gas and Mineral Corporation, Painted Post, N. Y., has been incorporated with a capital of $5,000 to deal in oil, coal, etc. Incorporators are W. Cumisky, R. B. Aayers, A. Bevier, of Painted Post.

The Pan-American Mica Company, Inc., Wilmington, Del., has been incorporated to mine and import mica and other minerals with a capital of $250,000. Representative, Samuel F. Frank, 170 Broadway, New York City.

The Panther Oil Company, Wichita Falls, Kan., has been incorporated with a capital of $25,000. Incorporators: Charles W. Bean, Frank Kell, G. C. Wood and I. Mackowitz.

The Pike Coal and Coke Company, Pittsburgh, Pa., has increased its capital stock from $1,000,000 to $5,000,000.

The Rau Oil & Gas Co., Oklahoma, Okla., has been incorporated with a capital of $500,000 to prospect for oil. The incorporators are Joe Williford, G. N. Otey, Max Rau.

Raybestos Company, Bridgeport, Conn., has filed a certificate of incorporation in Connecticut.

The Reade Manufacturing Company, Hoboken, N. J., has been incorporated in New Jersey with a capital of $20,000 to manufacture and deal in all kinds of chemicals. The incorporators are W. J. Reade, Jane E. Reade, Charles H. Reade, 1023 Grand St., Hoboken, N. J.

The Rex-Mar Oil and Gas Company, Parkersburg, W. Va., has been incorporated with a capital of $10,000. Incorporators: J. M. Connelly, R. G. Stiles, F. H. Rexroad and others.

The Richmond Flats Gold Mining Company, Butte, Mont., has been incorporated in Montana with a capital of $500,000. The incorporators are W. A. Reel, J. W. Stiver, W. W. Lamb, W. C. Sider, F. J. Furman. The property of the company is located near Norris, and the office will be in Butte.

The Schell Chemical Company, of New York City, has been organized with a capital of $15,000. Edward Schell, of West Rockaway, is one of the directors.

The Seven Eleven Oil and Gas Co., Tulsa, Okla., has been incorporated with a capital of $125,000. Incorporators: F. J. Sullivan, L. W. Mason and Harry Magoffin.

The Sheep Mountain Mining Company, Dover, Del., has been incorporated with a capital of $1,000,000. The incorporators are L. L. Cowan, R. Montgomery, D. J. Carter, of Chicago, Ill.

The Silk Printing and Dyeing Works, Inc., Bronx, N. Y., has been incorporated with a capital of $10,000 to dye and convert silks, cotton, etc. The incorporators are N. N. Goodman, J. M. and H. Goodman, 1218 Boston Road, Bronx.

The Solvay Process Company, of New York, has filed a copy of its articles with the Secretary of State of Utah, in order that it may transact business in that state in the development of the potash and salt fields. The headquarters in Utah will be in the Kearns Bldg., Salt Lake City.

The Star Refining Company, Yale, Okla., is a new incorporation with a capital of $20,000. Incorporators: R. M. Garner, A. B. Post and H. P. Barnett, of Yale, and E. E. Ryan, of Maramec, Okla.

The Stebbins Oil and Gasoline Company, Tulsa, Okla., has been incorporated with a capital of $750,000. Incorporators: M. F. Powers, G. C. Stebbins and C. A. Steere.

The Super-Six Oil Company, Pond Creek, Okla., has been incorporated in Oklahoma with a capital of $1,000. The incorporators are F. J. Contry, Ben W. Bird, J. H. Ullman, of Pond Creek.

The Texona Oil Company, Atlanta, Ga., has been incorporated with a capital of $25,000. Incorporators: J. H. Snipes, A. D. Marrs and R. G. Cooper.

The Titan Chemical Company, Cleveland, Ohio, has increased its capital from $1,000 to $200,000.

The Toyah Valley Sulphur Company, Houston, Tex., has been incorporated with a capital of $130,000. Incorporators: J. A. Daniel, of Houston; G. A. Plummer, of Beaumont, and A. A. Snell, of Toyah, Tex.

The Transport Oil Corporation, 43 Cedar St., New York. Capital $20,000. Deal in produce, coal, coke, chemicals, etc. The incorporators are R. G. Coad, J. A. Lederman, B. Lockwood.

Transue & Williams Steel Forging Corporation, New York, has been incorporated with a capital of $550,000 to manufacture and deal in metals, steel forgings, etc. The

incorporators are E. L. Durkin, W. J. Dupre, Jr., R. Bennett.

The United Alloy Steel Company of New York has been authorized to engage in business in Ohio by the secretary of state of Ohio.

The United Oil Company, Wilmington, Del., has been incorporated in Delaware with a capital of $500,000 to refine and distribute crude oil and its products. The incorporators are M. L. Rogers, L. A. Irwin, Harry W. Davis, all of Wilmington.

The Usoline Products Corporation has been incorporated in New York State with $500,000 capital. Business, oil refining. Incorporators: H. Rudolph, J. J. Bueb and P. O. Hoenig, 220 Cathedral Parkway.

The Velvet Copper Company, Dover, Del., has been incorporated with a capital of $500,000 to acquire and develop mining rights. The incorporators are Arthur W. Britton, Samuel P. Howard and L. H. Gunther, of New York City.

The Westerly Dye Works, Westerly, R. I., have been incorporated with a capital of $100,000 to do business in the plant of the Pequot Shirt Company at Westerly.

The Wharton Steel Company, owner of extensive iron ore deposits and three blast furnaces in northern New Jersey, is reported to have been purchased by J. L. Replogle, vice-president of the American Vanadium Company, and associates whose names have not yet been made public. The new owners intend to develop the properties extensively and to install by-product coke ovens. About 5000 acres of iron ore lands, of which the Hibernia mine is the largest, are included in the deal.

The Whitley Oil Company, Tulsa, Okla., has been incorporated with a capital of $10,000. Incorporators: Roy R. Poe, Ivan L. Jackson and Earl T. Miller.

Construction and Operation

Alabama

ANDALUSIA.—The Southern Cotton Oil Co. will rebuild its plant, recently burned, at a cost of $50,000.

BIRMINGHAM. — Former Governor O'Neal is understood to have gone to Montgomery with a delegation from the Board of Trade to attend a meeting of the U. S. Chamber of Commerce in order to urge the location of the Government nitrate plant at Muscle Shoals.

Arizona

CHLORIDE.—The Zinc Concentrating Co. is negotiating with owners of zinc properties at Rico and Chloride for the purpose of erecting a plant at Chloride for the treatment of ore in that locality.

JEROME.—George Mitchell, of Jerome, contemplates erecting a 1000-ton smelter, to cost $500,000.

MAYER.—The Great Western Smelters Corporation plans the erection of a 1000-ton copper smelter. Ernest Le Duc is president of the company.

MAYER.—The Stoddard Milling Co. expects to double the capacity of its flotation plant treating copper ores. This will bring the capacity up to 300 tons.

OATMAN.—The Big Jim Gold Mining Co. plans the erection of larger reduction plant to treat gold ores. A. G. Keating is manager of the plant.

PRESCOTT.—The Cash Mines Co. expects to install a 100-ton flotation plant to handle gold ores. N. H. Getchell is manager.

PRESCOTT.—The Maricopa Queen Oils Co. plans the erection of a reduction plant to treat gold ores at the New State mine. W. S. Wilhelm is manager of the company.

California

LONG BEACH.—The Long Beach Chemical Company will enlarge its plant on property leased from the Los Angeles Docks & Terminal Company. The plant will be located near the American Products Co., and Lorned Manufacturing Company.

LOS ANGELES. — The Pacific Coast Borax Company and the Solvay Process Company are reported to have in contemplation the joint erection of a large plant on Searles Lake in San Bernardino County, to produce potash, soda and borax, from the lake. Victor Barndt, of Tonopah, Nev., president of the Nevada Chemical Co., represents the financial interests which have been seeking to arrange for the operation of the plant under the mineral land leasing bill.

MARTINEZ.—The Shell Oil Company will begin work shortly on the third unit of stills at its refinery, increasing its capacity by one-third.

NEWARK.—A. Schilling & Co. has let contracts for the construction of a pond and refining plant on the marshes near Newark. The company will greatly increase its output of salt by this new addition.

OAKLAND.—The Pacific States Soap Company is negotiating for the purchase of a site on which to erect a new $100,000 plant.

SAN PEDRO.—Reported that the Union Oil Company is considering the erection of a $2,000,000 refinery.

Delaware

WILMINGTON.—The Wilmington Leather Company has let the contract to Joyce and Kerrigan for an addition to its plant, six stories high and 40 by 200 feet. The capacity of the plant will be doubled.

Illinois

CHICAGO.—The Sinclair Oil and Refining Corporation has acquired a site in East Chicago for the erection of a refinery. The property is convenient to rail and water. An 8-in. pipe line, 800 miles long, will supply oil to the refinery from the Kansas and Oklahoma fields. The refinery will be complete in every detail and when finished will have a capacity of 10,000 barrels per day. The company is also considering the erection of refineries on the Mississippi River and at Kansas City. Work on the pipe line has been commenced.

ROCK ISLAND.—The Illinois Oil Company has begun the erection of its new $50,-000 paint factory, adjacent to its present plant. All lines of paints will be manufactured and the capacity will be 10 cars per week.

Iowa

DAVENPORT.—The Sinclair Oil & Refining Company is planning the erection of a large refinery on the Mississippi River. Davenport, Rock Island, Fort Madison and Keokuk are all under consideration for the site.

DUBUQUE.—The Dubuque Tanning and Robe Company has completed a new plant at which all the company's tanning and manufacturing will be carried out. F. M. Rhomburg is president.

FORT MADISON.—The American Fork & Hoe Company has awarded the contract for a new plant, to cost $100,000.

Kansas

CROWLEY.—The Kawfield Oil Company, capitalized at $50,000, has started drilling on one of its locations near Crowley.

Louisiana

NEW IBERIA.—The Sugar Cane By-Products Company has purchased the Gebert shingle mill property, owned by the Norris Lumber Company, of Houston, Tex., and will begin the remodelling of the property and the installation of machinery for paper, pulp, and for working up bagasse, cotton stalks and rice straw. A chemical factory will be erected in conjunction with the paper mill to produce alcohol from bagasse. The cotton stalks, rice straw and bagasse were formerly useless, except as a low grade fuel for some purposes.

NEW ORLEANS.—Morris & Co., of the Chicago meat packers, plan the erection of an addition to their plant, to cost $100,000.

NEW ORLEANS.—The Stern Foundry & Machinery Company, 1630 Annunciation Street, is preparing plans for plant additions, to cost $100,000.

Maryland

BALTIMORE.—The Maryland Chemical Company, successors to the New Spar Products Company, has acquired a site on Columbia Avenue, and the Baltimore & Ohio Railroad, on which chemical factories will be erected. Several large buildings and a warehouse will constitute the group, in which the most modern equipment will be installed. Samuel Leibowitz is president and Edward F. Brundage is secretary.

Massachusetts

MANSFIELD.—The New England Drawn Steel Company plans the erection of a plant here. The company is capitalized at $250,000.

Michigan

CHEBOYGAN.—The Cheboygan Paper Company has been sold to the Union Bag & Paper Corporation, and it is expected that the plant will be enlarged and new machinery installed for making bag paper.

PETOSKEY.—The paper mill here, which is a branch plant of the Wheat Paper Company, of Elkhart, Ind., will resume opera-

tions as soon as repairs can be made and new buildings erected. Fire recently stopped work at the plant. The town will furnish free electric power for six months in order to give the company an opportunity to erect a fireproof power plant.

Minnesota

GRAND RAPIDS.—The Itasca Paper Company has begun the erection of additions and improvements to its plant, which will increase the capacity 20 per cent. The machinery has already been purchased.

MINNEAPOLIS.—The Mueller Furnace Company contemplates the erection of a $70,000 factory.

Mississippi

HATTIESBURG.—Work will be commenced shortly on a new $1,000,000 paper mill, to be finished by Jan. 1, 1918.

Missouri

KANSAS CITY.—The Nourse Oil Company will build a $100,000 plant for manufacturing oil specialties.

VALLEY PARK.—The St. Louis Plate Glass Company has opened bids for the construction of a new glass plant, to cost approximately $120,000.

Montana

HAVRE.—A campaign will soon be started by the Chamber of Commerce, to raise $30,000 with which to start a Farmers' Co-operative Flax Mill.

HELENA.—The Montana Testing & Engineering Company will erect an ore mill, to cost $30,000.

Nebraska

OMAHA.—Morris & Co. is erecting a new fertilizer plant at Twenty-eighth and P streets, to cost $40,000.

New Jersey

NEWARK. — The Lister Agricultural Chemical Company will erect a new bone block building, to cost $10,000.

New York

BAKERS FALLS.—The Union Bag & Paper Company plans the erection of a four-story paper mill.

BUFFALO.—The Kelly Island Lime & Transport Company, of Cleveland, Ohio, has awarded the contract to the Forest City Steel & Iron Company, Cleveland, Ohio, for a limestone crushing and storage building on the Buffalo River and Buffalo Creek Terminal Railroad. The cost with equipment is estimated at $250,000.

COLLEGE POINT, L. I.—The American Hard Rubber Company is erecting an addition to its plant to take care of increased business. About 200 more persons will be employed.

GLENS FALLS.—The International Paper Company plans the erection of a hyroelectric power plant at Glens Falls. The contract has been let to the H. P. Cummings Construction Company, of Ware, Mass.

LONG ISLAND CITY.—The Franco-Swiss Dyers, Inc., of Virginia, has bought ou the U. S. Coal Tar Products Company and will manufacture dyes and chemicals.

NEWBURGH.—The Fabrikoid Company is planning the erection of a large dyehouse, which will be larger than the present one. The company has a contract with the Clearfield Rubber Company, of Clearfield, Conn., to do all that company's dyeing.

NIAGARA FALLS.—The Isco Chemical Company's new plant has been completed at a cost of $450,000 and will manufacture caustic soda and bleaching powder.

NIAGARA FALLS.—The National Carbon Company has awarded the contract to the Snyder-Gillett Construction Company, of Niagara Falls, for erecting a $50,000 factory.

NIAGARA FALLS.—The Titanium Alloy Manufacturing Company has awarded the contract to the Peckham Construction Company, of Buffalo, for five 2-story factory buildings to cost $75,000.

POUGHKEEPSIE.—The Moline Plow Company has announced plans for the erection of a large addition to its foundry at a cost of $20,000. The contract for the construction has been let.

WOODSIDE, L. I.—The Holliday-Kemp Company, Inc., of 90 William Street, Manhattan, has leased the main building of the Consumers' Brewing Company at Woodside, and will begin the manufacture of dyes and chemicals early in November.

Ohio

CLEVELAND.—The Columbia Axle Company, of Cleveland, is having plans prepared for a factory on East 93d Street, to cost $250,000.

CLEVELAND.—The National Acme Manufacturing Company is having plans prepared for a new $300,000 plant.

CLEVELAND.—The National Artificial Silk Company has filed plans for the erection of a $55,000 building at Walford Road and Big Four Railroad.

COLUMBUS.—The Columbus Mill and Mine Supply Company is having plans prepared for a new combination warehouse and structural steel plant.

DAYTON.—The Duriron Company has purchased ground in which to erect an addition to its foundry.

DOVER.—A $600,000 cold-rolled steel plant will be erected here by a company headed by Herbert C. Greer, of Morgantown, W. Va.

McDONALD.—The Carnegie Steel Company is expected to shortly award the contract for furnishing machinery and equipment for the new McDonald mills. Machinery builders in Youngstown are seeking the contract. The machine shop of the new mills is already completed.

WARREN.—The Warren Mazda Lamp Company will erect an addition to its plant to cost $75,000. The contract has been awarded.

WARREN.—The West Side Electric Works plans the erection of a large addition to its lamp division in order that the greatly increased demand for lamps can be taken care of.

Oklahoma

CHELSEA.—The Marion Refining Company, of Claremore, Okla., is considering the erection of a refinery. A. M. White is president of the company.

OKLAHOMA CITY.—The Consumers' Refining Company will erect a chemical plant, to cost about $250,000. James A. Jones is president. The company is in the market for various equipment, such as filter presses, tanks, etc.

OKLAHOMA CITY.—The Oklahoma Oxygen Company, a new incorporation with $15,000 capital, will erect a plant for the manufacture of oxygen.

Pennsylvania

BETHLEHEM. — The Bethlehem Steel Co. issued a circular Oct. 30, announcing that it will spend $60,000,000 in additions to the plant which it purchased from the Pennsylvania Steel Co. Additional furnaces will be built at Steelton and Sparrows Point.

DUBOIS.—The Reliance Glass Factory has resumed operations under new management and is looking forward to a prosperous year. Glass is in good demand and high wages are being paid. The glass industry in general is rapidly assuming a flourishing condition. About 175 men will be employed at this plant. The cost of production has materially increased, due to the increased cost of raw materials and labor and glass prices will be increased accordingly.

KANE.—The plate-glass industry is enjoying a period of great prosperity, chiefly on account of the large export demand. Many of the manufacturers in this section have increased their capacity by erecting additional furnaces. The American Plate Glass Company recently completed two new furnaces, and they are now in operation. The price of plate glass has advanced 40 to 50 per cent during the last twelve months due to increased wages and cost of raw materials.

MARCUS HOOK.—Worth Brothers, who last year sold their steel plant in Coatesville to the Midvale Steel and Ordnance Company, have acquired 470 acres of farm land below Marcus Hook. The land is in Delaware, on the Delaware River, just below the Pennsylvania State line, and it is the intention to erect a $15,000,000 steel plant. Norman R. Entrekin will supervise the erection of the mills, which will be in close proximity to the large shipbuilding plants.

MEDIA.—The old Bridgewater Mills near Upland and Chester have been leased by a firm from New York, which will remodel the plant and begin the manufacture of chemicals.

NEW CASTLE.—The U. S. Steel Corporation is planning to use a large quantity of flue dust which has accumulated at its Farrell and New Castle works. Sintering plants will be erected and the dust will be used in the blast furnaces.

PHILADELPHIA.—The Dill & Collins Company, paper manufacturers, has purchased a group of factories adjoining its plant in Tioga from the Berg Company, and will remodel them.

PITTSBURGH.—The Atlantic Refining Company plans the erection of a 13-story building, to cost $1,000,000. W. G. Wilkins & Company are preparing the sketches.

SHARON.—The American Steel Foundries Company will enlarge its Sharon plant by the construction of two additional open-hearthed furnaces. The company now has five open hearths in operation. The two new ones will be of 40-ton capacity and will use oil fuel.

Rhode Island

PROVIDENCE. — The Royal Chemical Company has taken over the business of the Pawtuxat Valley Dyeing Company and will take up the bleaching and dyeing of yarns and textiles.

South Carolina

COLUMBIA.—The State Press Association discussed the high cost of paper at a recent meeting and decided to hold another meeting to take up the question of erecting a paper mill. D. R. Coker, of Hartsville, will be present to discuss opening a plant at Hartsville.

Texas

DALLAS.—The Texas Iron and Steel Company, which controls large tracts of East Texas iron ore lands, has acquired the rights to use a new process of iron ore reduction from the U. S. Reduction Company, of Chicago, a new company. Natural gas is used as the reducing agent instead of the coke in the process, which is the invention of Charles S. Bradley, well known as a pioneer in connection with the Bradley-Lovejoy nitrogen fixation work tried on a large scale at Niagara Falls a number of years ago. The United States Reduction Company controls the rights to use the Bradley iron reduction process in the United States.

FORT STOCKTON.—The Calumet & Arizona Sulphur Company is prospecting a sulphur deposit near this place. It is the company's intention to manufacture sulphuric acid.

Utah

OGDEN.—The Western Foundry & Machine Company will erect a $100,000 foundry as an addition to its plant.

Washington

NORTH YAKIMA.—The Utah-Idaho Sugar Company will erect a sugar plant to make beet sugar, to cost $1,500,000. Thomas R. Cutler is president.

SEATTLE.—The American Can Company's new plant is progressing nicely. The plant will cost $500,000 when all completed.

SEATTLE.—Options have been taken on iron deposits off the cost of Southeastern Alaska and British Columbia by capitalists who are believed to have in mind the erection of a large iron and steel industry in the Pacific Northwest. Steel-working and shipbuilding interests would become independent of the East if the large developments rumored should take place. Both Seattle and San Francisco are being seriously considered.

West Virginia

PADEN CITY.—The Paden City Glass Manufacturing Company has completed a new glass factory which will employ 300 persons. The Carter Iron Works plans to add two new furnaces during the next sixty days and the Art Glass Works is building a new addition to its plant. The town is located along the Ohio River, two miles south of New Martinsburg, and is experiencing a real boom.

WHEELING.—The Independent Glass Works are about ready to resume work. Since the last fire the company has purchased a building from the Wells Glass Company. Over 100 men will be employed.

WHEELING.—The Ra-O Chemical Company will erect a plant here for the manufacture of tooth paste.

Wisconsin

PARK FALLS.—The Flambeau Paper Company has completed plans for a paper mill here at Pixley Rapids, on the Flambeau River, six miles below Park Falls, Wis., to cost $125,000. The company is developing the rapids and will build a dam.

WINSTON JUNCTION.—The Zinc Contracting Company is planning to build a plant containing three roasters and six magnetic separators for the treatment of ore from this section.

Canada

HAMILTON, ONT.—The Hamilton Steel Wheel Company will erect a factory, to cost $200,000.

LULU ISLAND, B. C.—The Shell Oil Company, whose head office is in London, England, plans the erection of a $5,000,000 oil refinery to refine oils from western Canada and also California.

PORT COLBORNE, ONT.—The International Nickel Company is reported to have selected Port Colborne as a site for its nickel refinery. The British-American Nickel Company is also contemplating the erection of a nickel refinery to treat ores from its Sudbury properties.